Compressed Air Magazine

JUNE 1959

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URANIUM MILLING
ABOUT BAGPIPES
COAL, GYPSUM MAKE FERTILIZER
SEALING A SIEVE
INDEX AND COVER STORY, PAGE 3

6 Crawl-IR drills deliver

POWER-HOUSE PUNCH

at Rocky Reach Dam

This concentrated battery of fast-acting, mobile drilling power is sinking 25 to 30 foot holes for the main power house excavation at Rocky Reach Dam on the Columbia River, north of Wenatchee, Washington. Under construction by the Rocky Reach Contractors, this major project is a joint venture sponsored by the L. E. Dixon Company of San Gabriel, Cal. For high sustained drilling speeds, these six Ingersoll-Rand Crawl-IR drills are using $2\frac{3}{4}$" Carset bits and I-R Carburized Drill Steels.

The Crawl-IR units are also used to drill 90 foot grout holes around the circumference of the coffer dam.

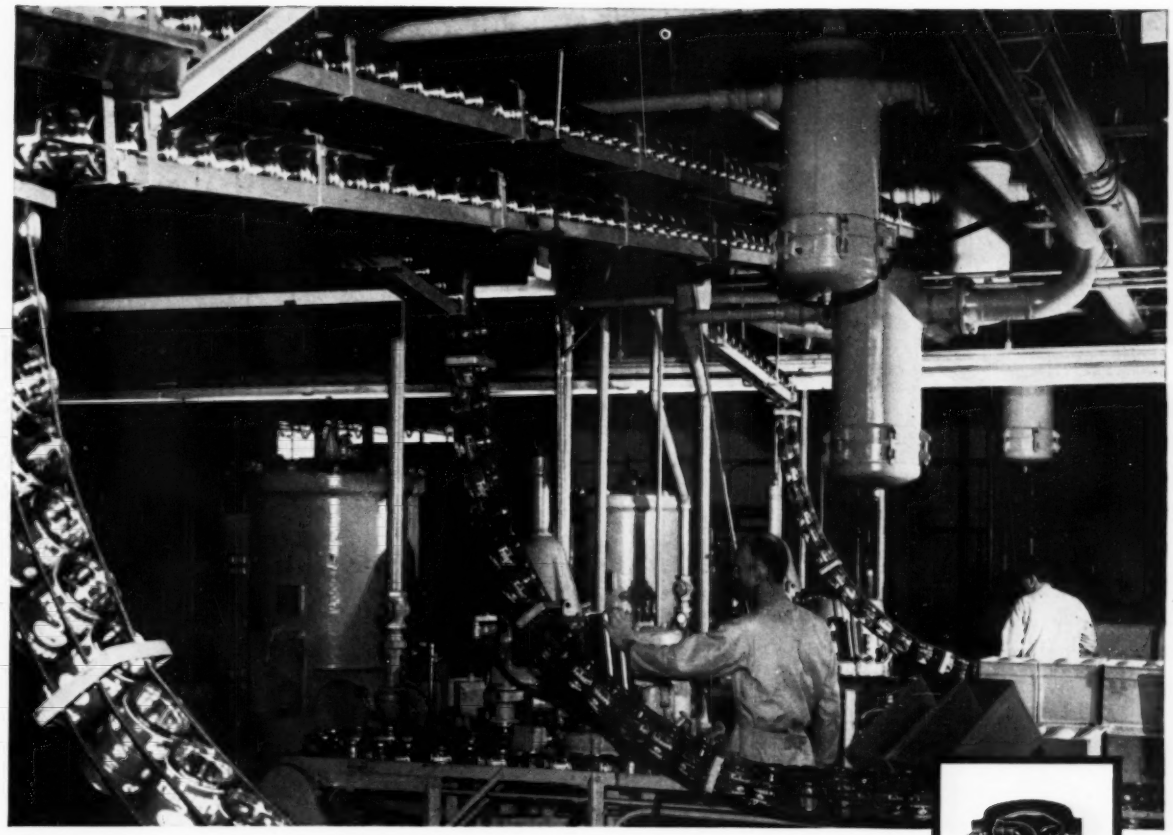
Ingersoll-Rand Crawl-IR drills are completely mechanized, heavy-duty units that convert setup time into *drilling time*. All motions—raise, lower, horizontal swing, extend, retract, and tower dump and swing—are powered by large, double-acting hydraulic cylinders, throttle controlled from a central operating station on each drill. Rugged I-R air traction motors, independently controlled, move the drill from place to place—permit fast, accurate hole spotting.

Ask your Ingersoll-Rand rock drill engineer for the inside story on why Crawl-IR is the strongest, most rugged crawler drill ever developed. Or send for new Bulletin No. 4208.

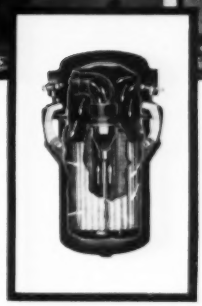
Ingersoll-Rand

11 Broadway, New York 4, N.Y.

A CONSTANT STANDARD OF QUALITY IN EVERYTHING YOU NEED FOR ROCK DRILLING



STAYNEW FILTERS KEEP TROUBLE FROM BREWING AT FOLGER'S COFFEE PLANT



Model CVH Staynew Filter used at Folger's. Filter inserts consist of Feltex 12 wool felt, are cleaned only once weekly.

At Folger's multi-million dollar plant in Los Angeles, Staynew Pipeline Filters play a vital role in vacuum packing—in fact, they literally keep trouble from brewing.

In vacuum packing shutdowns for pump repair cannot be tolerated. Pumps "suck" air from coffee cans before they are sealed for shipment. When this air is drawn off, some coffee particles are bound to come with it. At Folger's, Staynew Filters protect the vacuum pumps by preventing these particles from getting to them. Located between the production line and the pumps, Staynew Filters first mechanically clean the incoming air by forcing heavier particles into the base of the housing. Then, flowing through the Radial Fin Filtering Insert, any remaining airborne materials are removed, leaving only clean air to pass to the pump. Mechanical separation before filtering reduces the load on the filtering element. Low velocity with unusually low resistance to flow results. This keeps line pressures at the proper operating level and offers a tremendous saving in horsepower.

Designed to eliminate frequent cleaning, Staynew Filters contain a liberal space in the bottom housing for large particle accumulation — this can be drained off without shutdown. The Radial Fin construction of the filtering element provides an extremely big active filtering area—this means a greater amount of filtering over a longer period of time. For inspection and cleaning, large swing bolts permit removal of the lower housing, offering easy access to the filter interior without breaking pipe connections.

Assuring sustained, trouble-free operation of pumps at high load factors, Staynew Pipeline Filters have been successful in the packing of millions of pounds of coffee annually at Folger's. They've also gained wide acceptance in the processing of canned meat and other foods, and on vacuum degassing and high vacuum metal processing systems, to name a few. There's a Staynew Filter for every job—find out how you can save time and money on your particular application—consult a Dollinger representative, or write for Bulletin 200. Dollinger Corporation, 7 Centre Park, Rochester 3, N. Y.

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The one-piece NAYLOR Wedgelock coupling further simplifies the job and NAYLOR lines can be made up with only one side of the pipe in the open through this improved method of connection.

Whether you need pipe for fresh air, air under pressure or for handling water, it will pay you to write for Bulletin No. 59.

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Compressed Air Magazine

Founded 1896

VOLUME 64 NUMBER 6 **June 1959**

BRITISH EUROPEAN AIRWAYS PHOTO

ON THE COVER

STANDING on an ancient cannon battlement of the Castle of Edinburgh, this piper is a member of the famous Black Watch Royal Highlander Regiment, the oldest of the English bagpipe regiments. Its history dates from the early 1700's, and it still serves the rulers of England in performing many official ceremonies. The complicated bagpipe is one of the oldest of musical instruments still in use in nearly its original form. A member of the woodwind family, it is unique in that it is the only one of its group that is indirectly blown. *The Skirl Of The Pipes*, on page 20, tells of its complexities and manufacture.

FEATURE ARTICLES

Page 14 **Algoma Uranium, Milling Methods**—*R. J. Nemmers*
The importance of compressed air and vacuum to the extractive metallurgy of the Algoma field is detailed along with a discussion of ion exchange methods. This is the last of a series of articles on the largest mining development of recent years.

20 **The Skirl Of The Pipes**—*S. M. Parkhill*
Compressed air is the basis of many musical instruments; one of the oldest still in widespread use is the bagpipe. A description of what the pipes are, how they work and the way they are manufactured is given.

24 **Fertilizer From Coal And Gypsum**—*R. W. Sapora*
Discussed is an initial step, construction of a fertilizer plant, in an all-out effort by Pakistan to feed her hungry millions. Included is a description of the nitrogen fixation process starting with coal and gypsum.

27 **Sealing A Sieve**—*G. R. Smith*
The hydroelectric development of British Columbia has presented a number of related problems for which unique answers have been found. One is the internationally flavored Soletanche grouting process that is being used to bind a porous dam site.

30 **Bin For Grocery Boxes**
An air-actuated platform installed in a supermarket helps keep the store attractive, and at the same time eases employees' manual efforts. Such a lift could be used equally well in shipping departments.

34 **With Air, A Smoother Finish**—*Selwyn Tucker*
A blast of compressed air helps chip removal, resulting in a smooth finish for milled brass sheet.

DEPARTMENTS

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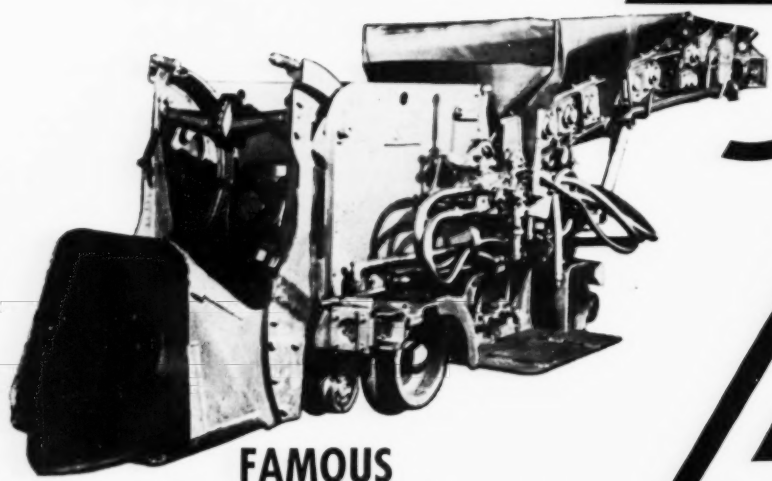

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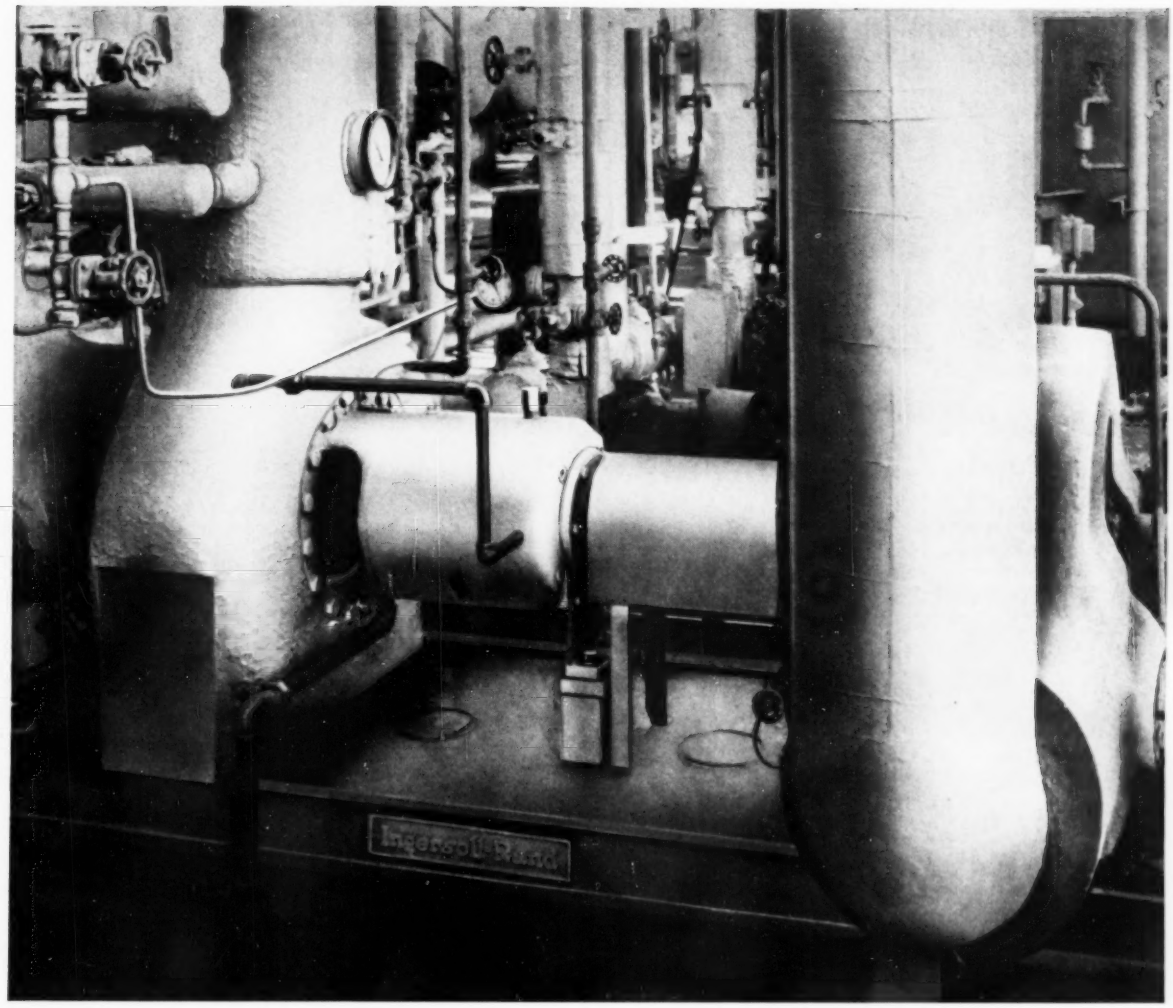

Chromium-Nickel stainless steel takes pump into its 4th non-stop year . . . circulates 246°F urea

There's no spare for this stainless steel pump. Yet it's essential to the process — recirculates 4600 gpm of corrosive urea-and-oil.

It needs no spare because Ingersoll-Rand makes casing and impeller of a specially developed chromium-nickel stainless steel . . . gives extended service in organic acids. The pump shaft is made of a similar stainless steel.

Now in its 4th year, the pump has never had a forced shutdown for maintenance. There's every sign it'll do its job for years to come.

Nickel-containing stainless steel muzzles corrosion's bite in many other processes.

For instance— a centrifugal rotor of cast ACI type CF-8M stainless shows no corrosion after 12 years' service in slurries of warm weak sulfurous and lactic acids. Or—a hopper of chromium-nickel stainless handles hot magnesium carbonate slurry without product discoloration or excessive down time. Basic toughness of the stainless in this hopper cuts down metal loss from abrasion.

Good workability, too.

Austenitic stainless steels are readily formed by drawing, spinning, bending and shearing. Welding, soldering, hot forging and riveting are comparatively easy.

Where you find corrosion a threat, the austenitic stainless steels may well be the most practical materials you can use. Write Inco's Corrosion Engineering Section for advice on your specific corrosion problems.

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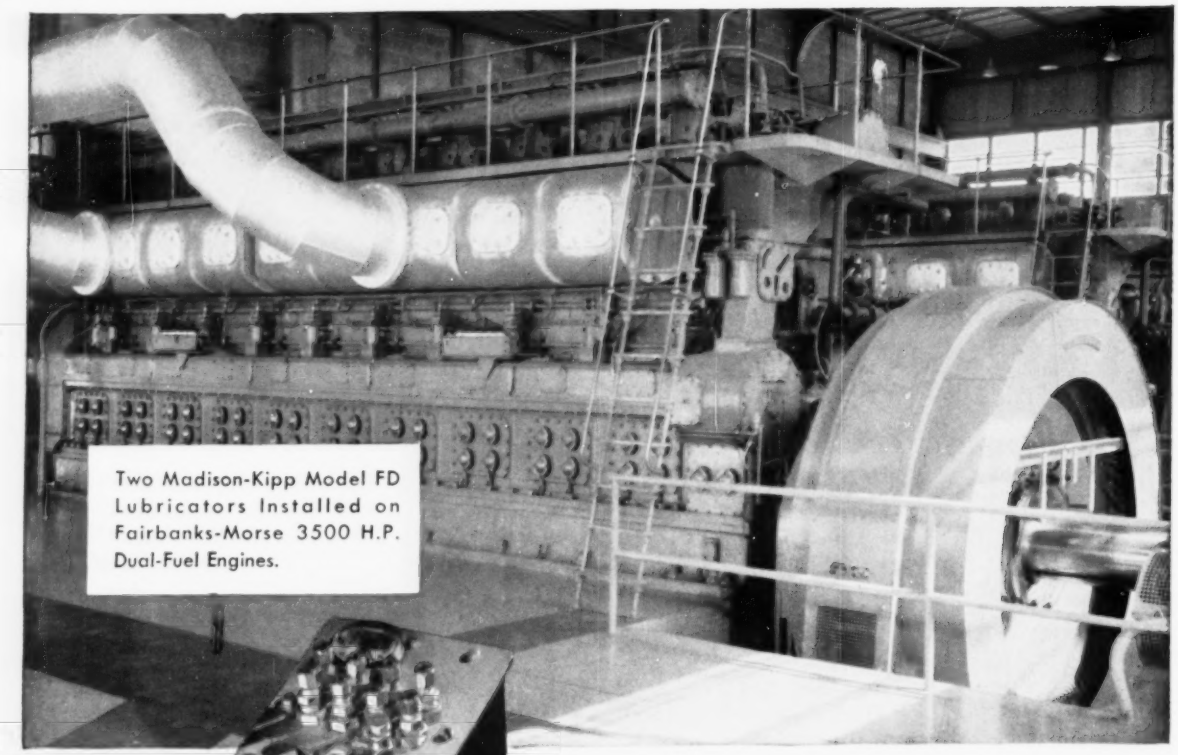

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Biting deep into limestone in Mississippi River bluffs

Here Bethlehem Hollow Drill Steel is drilling a 72-hole-round, blast-hole pattern at the huge limestone quarry of Solvay Process Division, Allied Chemical Corporation, at Prairie du Rocher, Ill.

The quarry management is using the room and pillar method of rock removal. Faces in the Salem Limestone are 30 ft high, and about 50 ft wide. The Bethlehem Hollow, fitted either with one-use or carbide-insert bits, drills holes as deep as 15 ft.

You can always count on economical drilling with Bethlehem Hollow. It's tough and fatigue-resistant, and has a uniformly round hole. And having a wide quenching range, Bethlehem Hollow is easy to heat treat so that you get the right degree of toughness and wear-resistance for strong threads and long-wearing shanks.

Bethlehem Hollow Drill Steel is furnished in Carbon and Ultra-Alloy grades in rounds, hexagons, and quarter-octagons. It comes in easy to handle lengths from 18 ft to 27 ft, and longer.

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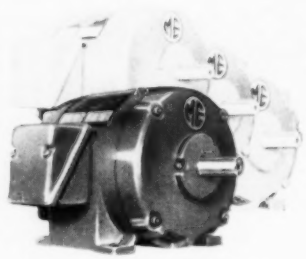

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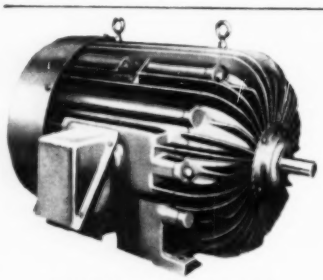

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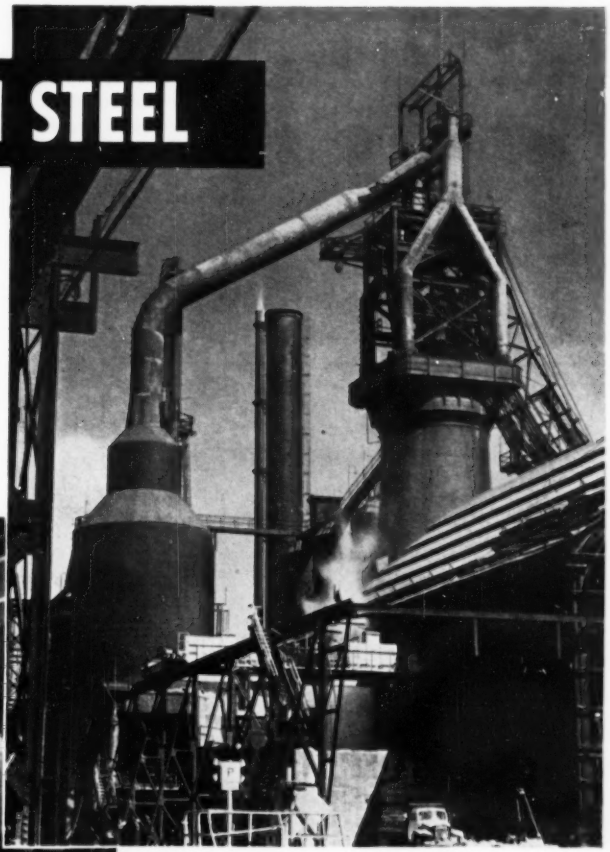
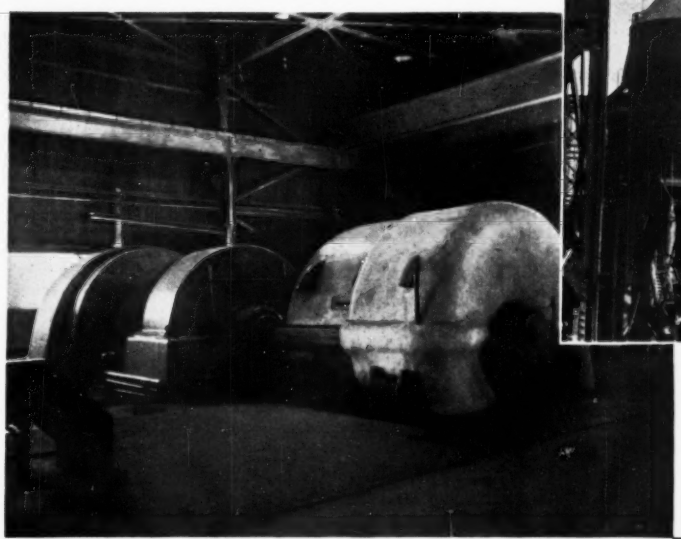
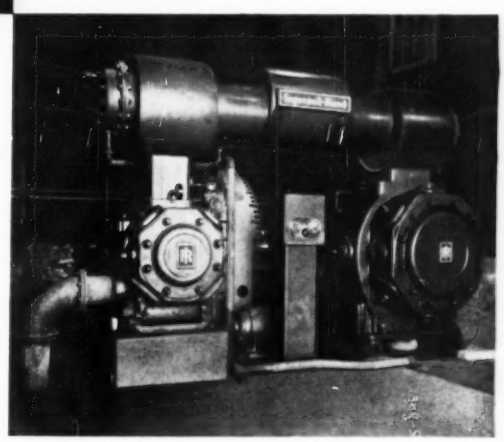




One of two Ingersoll-Rand 50,000 cfm Blowers supplying air for Compania de Acero del Pacifico's blast furnace, shown above.

One of seven Ingersoll-Rand two-stage, synchronous-motor-driven Class PRE air compressors on air and gas service.



FOR THE past nine years, Compania de Acero del Pacifico has been producing high grade steel for the growing industrial market of Chile. And, like the market itself, the Huachipato Plant, located on San Vincente Bay, has been growing in capacity and diversity of steel production. For example, expansion and modernization of facilities and equipment increased ingot output from 189,000 tons in 1951 to 427,000 tons in 1957.

Air for the blast furnace is provided by two electrically-driven I-R Blowers, each rated 50,000 cfm, 30 psig discharge. Electric motor drive is used instead of conventional turbine drive because of the scarcity and high cost of fuel in Chile and the abundance of hydro-electric power.

The Bessemer converters are supplied by another I-R Blower that delivers 26,500 cfm at 25 psig. And the mill's compressed air and gas needs are provided by seven Ingersoll-Rand Class PRE compressors totalling 3300 horsepower. Other I-R equipment installed here includes a Class ES vacuum pump and two air-cooled T-40 compressors.

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CHOICE OF PACKING. Dynatex is available in multiwall paper, special burlap or Flexo-Bag® containers, or in fiber drums of standard diameters.

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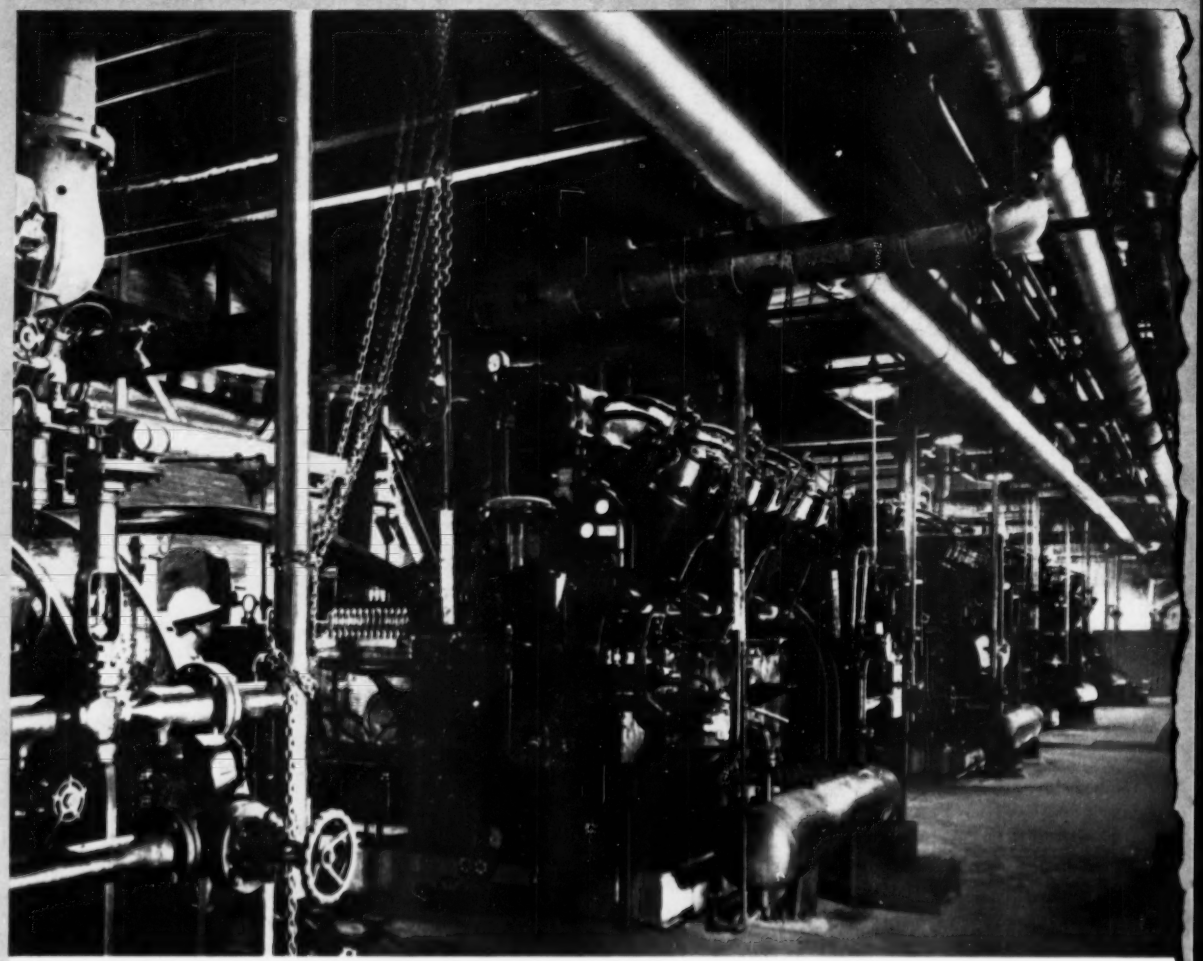

Cellulubes by Celanese minimize threat of fire

Protection of your personnel, plant and equipment against fire and explosion is a vital need. Cellulubes made by the Celanese Corporation of America can help you provide this protection. They resist the propagation of flame under conditions which could result in serious fires with other lubricants. And they give you so much more!

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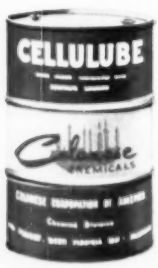
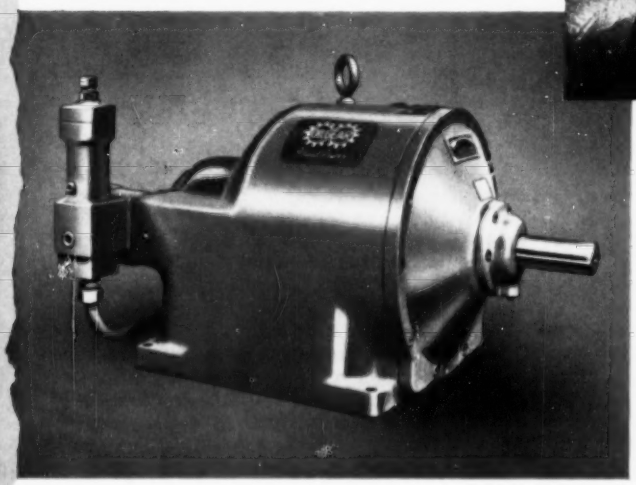


FM

Factory Mutual-Approved
(Cellulubes 150 and 220)

CYLINDER WEAR PROVED NEGLIGIBLE when fire-resistant Cellulubes were used to lubricate four Cooper-Bessemer air compressors, as two years' testing showed. Moreover, there were no pressure surges or evidence of fire in the air accumulator. Deposits normally found in compressor auxiliaries and valves were reduced or eliminated thanks to the detergent action of Cellulubes. Conventional lubricators could be used to pump the Cellulubes.

SAFETY, EFFICIENCY, COST SAVINGS are the advantages of Cellulubes discovered by Trunkline Gas Company Texas, after using these lubricant fluids for three years in their air compressors: Cellulubes eliminate risk to personnel from fire, explosion, fragmentation. Cellulubes do not get dirty or burn away by friction or compression. Cellulubes save on replacement costs, downtime, and maintenance. Cellulubes keep machinery smooth-running and clean.



USED FOR YEARS under rigorous conditions in pumps made by the Oilgear Company of Milwaukee, Wisconsin, Cellulubes provided superior protection against excessive wear. Cellulubes, which are phosphate ester synthetic fluids, can be employed in pumps at higher temperatures than fire-resistant fluids which contain water. They are suitable for use in all types of hydraulic pumps being used today, including vane, piston and gear pumps.

and explosion...protect machines against wear

For example, Cellulubes give overall wear protection comparable to that of premium petroleum oils. They present no foaming problem and have no additives which might deposit in the system. In fact, these synthetic lubricants and hydraulic fluids have a cleansing action inside machinery. Their vapor pressure is extremely low; this means that fluid losses are negligible even under severe operating conditions. Cellulubes are available in six viscosity ranges to meet all the standard needs of industry. Viscosity ratings do not change despite the toughest conditions of mechanical shear.

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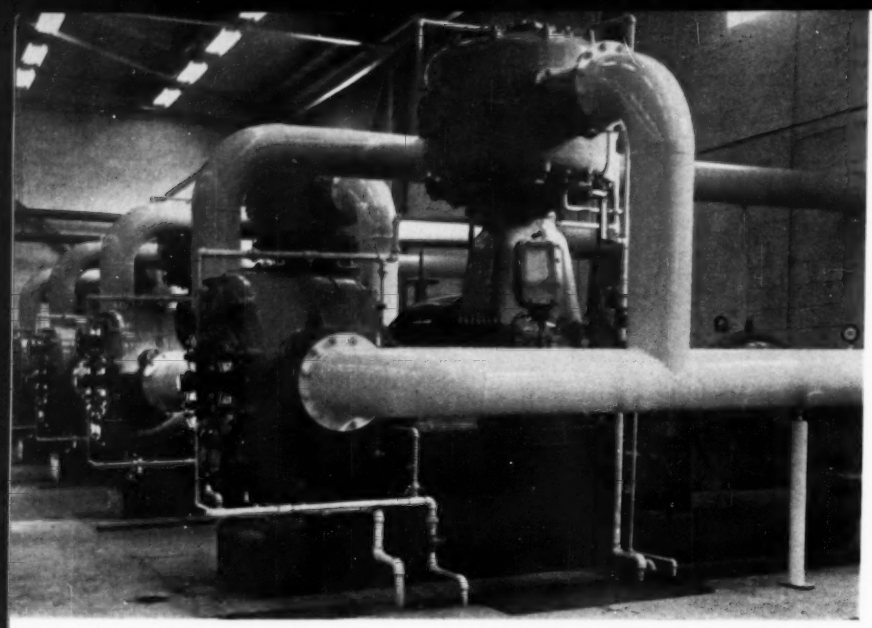
CELANESE CELLULUBES



VACUUM PUMPS

All of the 43 vacuum pumps in the eleven mines and mills of the Elliot Lake region are Ingersoll-Rand units. Five XVH machines are shown in this view. All told, the pumps aggregate 9550 hp and have a total capacity of 210,910 cfm at 28 inches of mercury vacuum. Most of the mine and mill compressors are also XVH units, almost 78,000 cfm of the total 79,000-cfm mill air capacity, and some 92,000 cfm of the total 93,500-cfm mine air capacity being furnished by that type machine.

Algoma Uranium

R. J. Nemmers

Milling Methods

FROM Pronto on the south, to Algom Quirke on the north, the ores of the Algoma uranium beds are of a most uniform nature. Metallurgical processes for extracting the yellow oxide from the ore thus differ very little from mine to mine. Grade of oxide does not vary substantially.

When Joubin first made his discovery and shipped samples to the Department of Mines & Technical Surveys for extraction experimentation, the so-called brannerite ore presented many problems. Generally extremely refractory in nature, the ore defied attempts at preconcentration. Because of the low grade of the ore, it was absolutely necessary that an inexpensive process be found, otherwise the Joubin deposits were valueless.

Eventually the puzzle was solved by application of leaching techniques: use of strong acids at relatively elevated temperatures. The resultant leach liquor, even though low in grade, could then be made to give up its uranium values by means of a low-cost ion exchange process similar to that worked out only a few years previously for use with South African ores.

Essentially, the process consists of grinding mine-run ore; leaching it in acid; separating the uranium from the liquor by means of ion exchange adsorption on a resin base; stripping the uranium values from the resin; and precipitating, drying and packaging the resultant oxide.

Because the processes and equipment in all mills are so similar, only a typical plant will be described, differing practices and apparatus being detailed as each stage is treated.

Chemistry

Before going into the full description, it is necessary to examine briefly the chemistry of the process. As indicated in previous sections, the ore is relatively low grade, the altered brannerite (uranium titanate) occuring in the interstices of a conglomerate formation along with uraninite and some other uranium compounds in lesser quantities. The values are frequently accompanied by pyrite and pyrrhotite.

These ores are leached in sulphuric acid, a minimum acid strength of 5 percent or about 100 pounds of acid per ton of ore being required, although acid recycle systems now in use can reduce the over-all consumption to a total of about 65 to 70 pounds per ton. The leach slurry must be maintained at a temperature of at least 45° C (113° F), otherwise effective dissolution will not take place. When these conditions are realized, uranium in the UO_3 state is readily dissolved, and that in the UO_2 state is oxidized to the O_3 for eventual entry into solution. The actual oxidation step is advanced by ferric iron made available in the mixture by the oxidation of dissolved mill iron by sodium chlorate. Although other side reactions take place, the relatively simple solubility steps outlined are the main ones in the extraction of uranium.

Ore preparation

In all of the mills, the ore is ground in a neutral (that is, nonacidic) suspension. Coarse ore from the mines in each case is fed to primary crushers either above or below ground. Universally these are jaw crushers ranging from 30x42 to 48x60 inches and discharging to Symons cone crushers with side openings of ⅞ inch to 1¼ inches. All, except at Pronto mill, produce an end feed suitable for rod mills. (At Pronto, the primary units put out a slightly finer feed for ball mill usage, no rod mills being in the circuit.) The secondary (cone-crusher) crushing is followed by screening at ½-inch to remove all possible grinding mill feed prior to final crushing in short head cone crushers of nominal ⅜-inch settings.

Rod mills vary in size from 7x10 to 10½x14 feet, ball mills ranging from 9x10 to 10½x13 feet. Output from the grinding section is classified to approximately 55 percent minus 200 mesh. The overflow of the classifiers is directed to dewatering thickeners where the slurry is reduced to one of about 63-percent solids. The overflow from the dewater-

ing thickeners is sometimes returned to the grinding circuit to reduce water consumption.

At this point in the circuit and at others as required, a compound called Separan is added to the slurry to assist in gaining a clean overflow. Also, either an acid or base must be added to gain a clarified mixture; glues are added to aid filtration. Then the slurry is carried to neutral disc filters. This is the first important use of compressed air and vacuum in the milling operations. The filters at the mills are of varying diameter and have either eight or ten discs each. Each disc is divided into sections and each section is piped independently of other sectors so that vacuum can be applied as the section dips into the slurry, and compressed air applied as the section rotates on to the scrapers where the pulp is removed. This pulp is then put back into suspension in acid and the leaching begins.

The acid circuit

Leaching is carried out either in agitator tanks or in Pachucas. An agitator tank is of wooden stave construction (a usual size being 32 feet in diameter by 30 feet in depth) and rotating within it is an agitator that keeps the pulp in suspension. A central air-lift column is also used in this type agitator to aid the circulating action. All metal parts within reach of the acid solution must be either of stainless steel or covered with rubber to prevent corrosion. A Pachuca is a mild steel tank with a 60-degree cone at the bottom, rubber lined throughout. Compressed air introduced to the tank through stainless steel piping at the bottom bubbles through and circulates the pulp mixture. Pachucas vary from 15 feet in diameter by 37 feet in height to 22½x50 feet.

Although both agitators and Pachuca tanks are in use, engineers now tend to prefer the Pachuca tanks for the rapid segregating Elliot Lake ores. If mechanical failure by chance should shut down one of the agitators for more than just a few minutes, it is almost impossible to restart it because of settlement. It has been found necessary to add glue to the agitator tank mixture to help keep it in suspension. For Pachuca tanks, shutdowns of up to ½ hour or more can be tolerated and the circulating action restored by admission of high-pressure air and water to the cone bottom. Further it has been found that glue is not required except in the last of the series of Pachuca tanks used for the completion of leaching.

As previously stated, a temperature of at least 45° C is required for effective dissolution and this temperature, or higher ones up to 49° C in some mills, is attained by admitting live steam directly into the solution. The leach mixture is drained through the series of agitators over a period of about 50 to 60 hours. Allowing for some short circuiting of the mixture as it is drained through launders from tank to tank, the effective over-all leaching time is at least 45 hours.

From the last of the agitators, the leach mixture is transferred either to acid disc filters, or to neutralizing vats. The acid strength of the leach at this point is too great for the ion exchange circuit, and thus must be reduced in some way. The obvious of course is by the addition of a base such as lime to the solution. This method is costly in that it requires the addition of lime that otherwise would not be required and also because it wastes acid. The alternate is acid recycle which is now in use at many of the mills. The equipment required for recycle is a bank of stainless-steel-outfitted disc filters. Synthetic (Dynel) canvas is used as the filter medium, otherwise the design is the same as the neutral disc filters including sectionalizing for application of air and vacuum. The filtrate is returned to the circuit at the repulpers following the neutral disc filters and thus effectively reduces the over-all acid requirements by about 30 percent. Further, because the solution is hot, it reduces steam requirements.

The pulp, after being blown from the filters, is mixed with water for washing to remove all of the soluble uranium from the moist cake. This washing slurry passes first to pH adjustment agitators or Pachucas where lime is added in small quantities to make the final adjustment of pH to that required by the ion exchange section. Then the mixture goes to washing thickeners where the pregnant solution is delivered as overflow. The next step is to remove the barren solids. The mills vary in the equipment with which this is accomplished. Most use washing drum filters; one, 5-step counter-current decantation. The washing drum filters are in two stages, the barren pulp being picked up by each in turn. Vacuum, of course, is applied to the drum filters. The solids are thoroughly washed at each stage and are repulped between stages. A portion of the filtrate is used to repulp the cake from the acid disc filters, the remainder being recycled to thickeners.

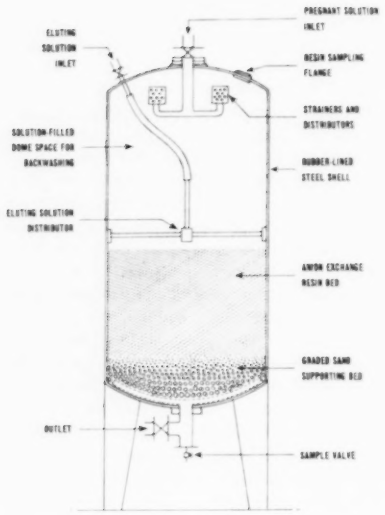
In counter-current decantation (CCD) the solids flow through a series of five tanks. The washing solution flows in the opposite direction. In this way the "cleanest" wash water washes the "cleanest" solids resulting in most effective stripping of solubles from the barren solids.

The choice of washing drum filters or counter-current decantation depended on many factors. One which was of vital importance had to do with the lo-

CCD TANKS

Shown here is an aerial view of the ten giant (100-foot diameter) counter-current decantation tanks at Algom Quirke. The slurry is washed progressively in five tanks to remove all traces of uranium. The overflow from the last tank in the line is the pregnant uranium solution—the underflow, the so-called barren solids.

PHOTO, CANADIAN INDUSTRIES LIMITED.



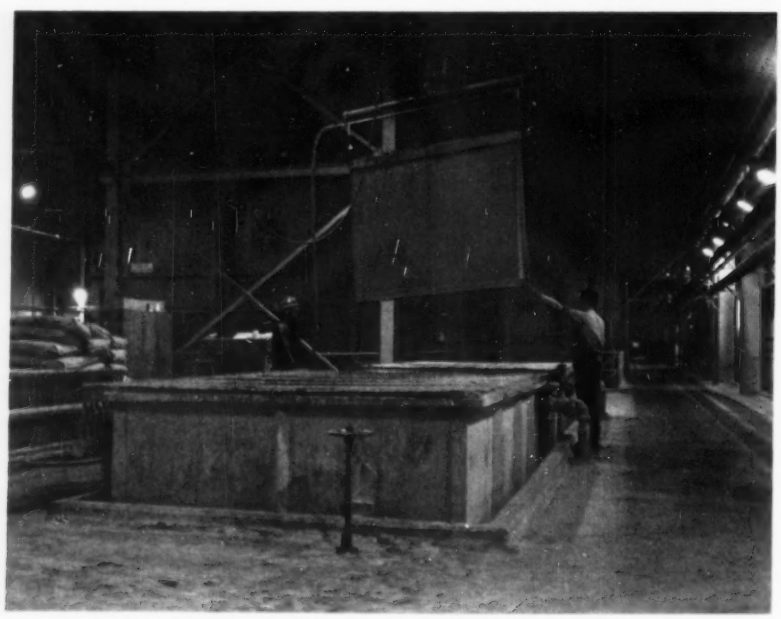
ION ECHANGE

Control of ion exchange circuits is handled in the mills by control panels much like the one shown at the left. Many of the control circuits are energized and many valves are operated by compressed air. At the right is a diagrammatic sketch of a water-dome ion exchange column.

cation of the mills. The CCD tanks are each of 100-foot diameter. Only one of the mills (Algom Quirke) had enough level ground available for the huge installation required. Quirke has two sets of tanks—ten in all—for its system.

As the barren solids are discharged from the mill, they must be neutralized of remaining acid. Air is required to oxidize and precipitate ferrous salts. Then lime is added and the tailings held for a reaction time of about 2 hours before being pumped to a dump. Within the Rio Tinto group of mines, backfill plants have been designed to recover the sands from the tailings with the idea in mind that these will be used for backfill in the mines. At the present time, only Algom Quirke's installation is complete.

The pregnant solution from the washing thickeners contains a small amount of solids. These microfine particles could cause mechanical blockage of the ion exchange circuit and thus must be removed. This is done in leaf filters or clarifiers. The solution enters a tank containing 50 leaves. These are individual frames covered with canvas twill or Dynel. A vacuum of about 25 inches Hg is applied to each leaf independently. The filtrate from each leaf is combined in a manifold and thence is pumped to the clarified pregnant solution storage tank. From there it is drawn as required for the ion exchange columns. As each leaf becomes laden with sand, it is individually removed from the tank and washed.



LEAF CLARIFIER

Shown here is a clarifier leaf being swung back into position in its tank after being removed for cleaning. Each leaf is independently connected to a vacuum header as well as to a clarified pregnant solution header. The clarifier removes all traces of sand that might otherwise coat or plug the ion exchange resins. In the background is a portion of one of the giant wooden-stave leaching tanks.

Ion exchange

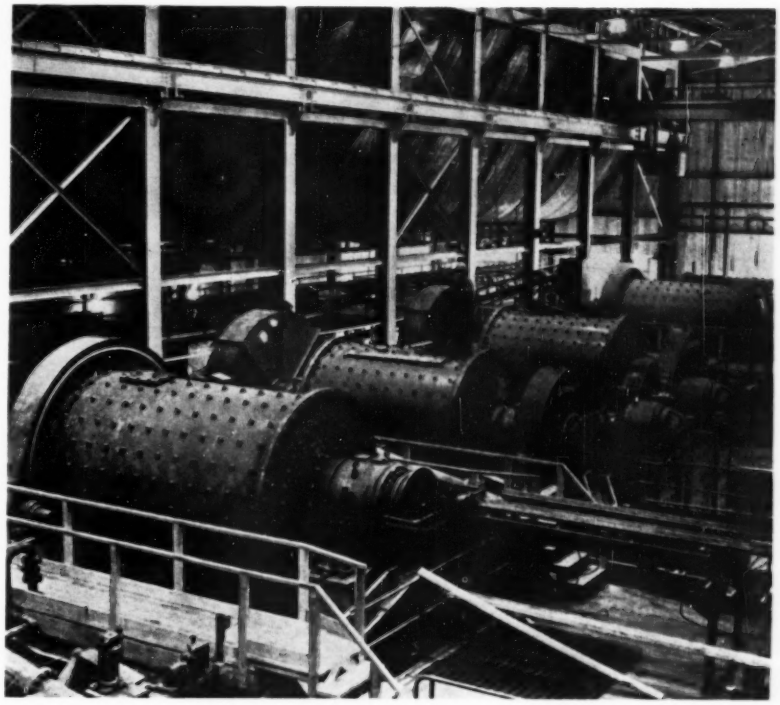
Three different types of ion exchange equipment are in use in the area. The first has fixed resin beds with water domes. A set of these consists of three hard-rubber-lined tanks, 8 feet in diameter by 14 feet deep. Inside a column are 14 inches of graded gravel and a resin bed 5 to 6 feet in depth. The rest of the column is filled with solution during the adsorption cycle. During backwashing, to clean the resin, this portion of the tank is used for a 100-percent expansion of the resin bed. The tanks are fitted for coupling as follows: AB, BC, CA. In following a complete cycle, it is seen that the pregnant solution enters A first, then goes into B and emerges as a barren solution. In the meantime, C is being stripped or eluted. When A is fully charged, pneumatically operated and controlled valves switch the flow to B first, from which the semi-barren liquor flows to C for final adsorption. A, meanwhile is being stripped. When B is fully loaded, C and A are used in that order. Thus the cycle is completed.

The second type is the fixed bed, air-dome variety. Four 8x14-foot tanks are used for this, and all are very similar to the water-dome type. Liquid level in the tanks is controlled by use of high

pressure air in the dome over the resin beds. On backwashing, the air is released allowing the bed to expand. With four beds in the circuit, the tanks can be interconnected as ABC, BCD, CDA, DAB. In each case the pregnant solution is circulated through the tanks in the order given and the fourth tank is being stripped.

The last method is one utilizing moving resin beds. A set of columns consists of six adsorption columns in two sets of three, a backwash column and a set of three elution columns. The adsorption and elution vessels are 8x14 feet, but the backwash vessel is 8x16 feet. This permits the use of larger quantities of resin in the adsorption and elution vessels while yet making available the space needed for expansion of the resin during backwashing. During operation three columns in series are used. When the lead column is fully loaded, it is flushed with water to move the uranium-bearing solution to the next column and its resin is moved to the backwash vessel. Thence it goes to the elution vessel and after being stripped of values, is returned to adsorption. Each resin bed is successively the third, second and first bed in the adsorption cycle and then, in the same order, in the elution cycle. Such an arrangement permits great efficiencies in the over-all operation of the plant and is of help in maintaining full flows even when mechanical blockage and resin poisoning have progressed quite far. The solution or liquor, after passing through the ion adsorption cycle, is known as barren effluent and as such is neutralized with lime and disposed.

The eluate gained by stripping uranium from the resin beds consists of a solution of uranium, iron, thorium, sulphates, etc. The impurities are removed in a precipitation step by passing the eluate into a series of three Pachucas where slaked lime is added to raise the pH value to 3.3 to 3.5. At this acidity, the impurities drop out of the eluate leaving a solution of pure uranium. The overflow from the last precipitation Pachuca goes to a deep well thickener where the precipitate is allowed to settle out. The overflow is then passed to a set of agitator tanks where magnesium oxide and/or sodium hydroxide and/or anhydrous ammonia is added to raise the pH value to 6.7 to 7. In this range, the clear solution dramatically turns bright yellow as the uranium oxide precipitates from it. The eluate is retained in the gypsum precipitators for slightly more than 2 hours; in the second stage uranium precipitators, it is held for about 1 hour 40 minutes to 2 hours. The precipitated solution is sent to thickeners and the underflow, filtered on drum filters, is the uranium oxide. From the drum filters, the product is repulped and then dried to a moisture content

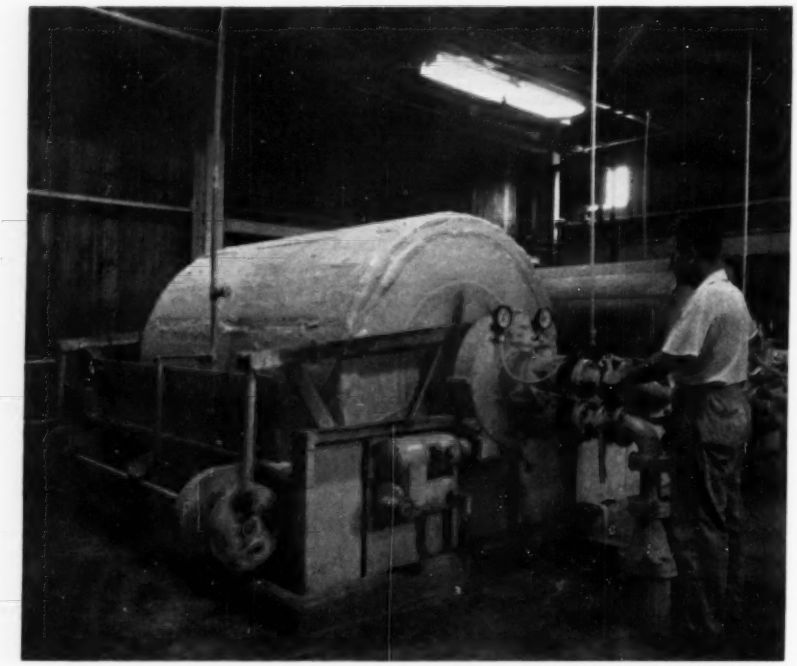


ROD AND BALL MILLS

Algom Quirke's grinding mill circuit is shown in this illustration. In the background is the catenary bin that holds fine ore. In the foreground is a rod mill, the table or rack at its mouth holding rods in position for loading. The next two machines in the line are ball mills. The latter units make the final reduction in ore size prior to feeding to the acid leach circuit. Throughout the area there is about 0.75 hp of installed primary and secondary grinding capacity per ton of mill capacity. About 3 to 4 pounds of rods and balls are consumed per ton milled.

ACID SUPPLY

Two new sulphuric acid producers were required to meet the demand of the Algoma region mills. One (shown here), built by Canadian Industries Limited delivers 300 tons per day of the acid. It is located at Copper Cliff, Ont. The other, built by Noranda Mines at Cutler, Ont., has a daily capacity of 1000 tons per day. With acid recycle systems, about 65 to 70 pounds of acid is required per ton of mill capacity—without acid recycle, approximately 100 pounds per ton.



PHOTO, CANADIAN INDUSTRIES LIMITED

DRUM FILTERS

One of the most important tasks of vacuum in the milling operations of the Algoma field is that of aiding filtration. Besides the drum filter shown—which is removing precipitated uranium from solution—there are disc filters and leaf clarifiers. The fact that many of the solutions that are filtered are acid means not only that certain filters need be of stainless steel construction and utilize synthetic canvas media, but that extra rigorous conditions are imposed on the vacuum pumps.

of less than 10 percent. It is then packaged in drums of about 300-pound capacity for shipment.

One dryer installation serves the two Algom properties: located at Nordic, the oxide from Quirke is transported to it by tank truck as a repulped slurry. A similar condition prevails at Northspan properties where the uranium slurry is shipped to Lacnor from Panel mill as well as from Spanish American, when the latter is operating.

The one great variation in mill practice consists of a $1,000,000 thorium extraction set-up recently opened at the Quirke mill. Built and owned by Rio Tinto Dow Limited (a firm jointly owned by Dow Chemical of Canada and Rio Tinto), it is the first thorium extraction plant in Canada. It is designed to recover thorium from the wastes of Algom Quirke mill and to produce a calcined thorium oxide. At present, the mill is being operated on an experimental basis as the theoretical processes are proved.

Air and vacuum

As indicated in the descriptions of the processes, compressed air and vacuum play important roles in the extraction of uranium from the ore. Disc and drum filters require vacuum; agitator tanks and Pachucas require large volumes of low-pressure air. Throughout the area there is an installed mill capacity of approximately 78,000 cfm of air at pressures ranging from 35 to 45 psig. Most

About Ion Exchange

URANIUM is now in a temporary state of oversupply. The atomic energy authorities of the free world are taking steps to delay development and production of new sources of supply. It is generally agreed, however, that uranium would today be in even shorter supply than in 1945 were it not for the development of the ion exchange metallurgical methods that are used in many of the free world's largest uranium ore treatment plants. That this new extraction method is the key to the atomic age is an understatement—without the plentiful supplies of uranium it has made available, the age of atoms would hardly have gotten off the ground.

Credit for development of the ion exchange method into one that could be used on a large scale in extractive metallurgy goes to South African researchers who first applied it successfully to the gleaning of uranium values from the renowned gold reefs of the Union of South Africa.

To understand how this process works, it is necessary to review some basic chemistry. Most metal salts when in solution form ions. Each of these ions has an electrical charge, some positive and some negative. The positive ions are called cations; the negative, anions. Because the solution must be neutral from an electrical standpoint, there are always as many units of positive charge as there are units of negative charge.

Another property of ions is that some have an affinity for one another and in solution will group together forming large complex ions that also will be either positively or negatively charged.

This brings us to ion exchange materials. Perhaps the best description of these lies in an analogy with a sponge. Grains of ion exchange material, whether naturally occurring and inorganic in nature (such as the zeolites used in ion exchange water softening); or of the organic synthetic resin variety (the type used in uranium extraction) may be visualized as tiny sponges. Clinging firmly to the walls of these sponges are ions, while adhering loosely to the perimeter and in the pores are ions of opposite charge, thus preserving an over-all electrical neutrality. The firmly attached ions cannot be removed except by chemical destruction, yet those of opposite charge that are only loosely associated with the ion exchange material oftimes may be easily replaced by the adsorption of other ions of the same charge. In general, ion exchange materials have a greater affinity for ions having the most units of electrical charge. The fact that they are of a sponge-like make-up greatly increases the adsorption area of each small grain.

Resins with firmly attached positive ion groups can exchange negative ions and are called anion exchange resins; similarly, those with firmly attached ions exchange positive ions and are called cation exchange resins.

To return to the ions, ionic uranium was shown to have a great affinity for sulphate ions, the two forming a complex having a relatively high four units of negative electrical charge. It was thus easy to pick out an anion resin having a particular affinity for the uranyl

common of the compressors in the area are Canadian Ingersoll-Rand single-stage XVH units, either direct connected or belt driven. Forty-one of the total 47 units are of this type. The remainder are typified by the C I-R Type ES which is a single-stage, single-cylinder unit. There is a total of 875-hp of this type of compressor in operation.

Vacuum pumps are all of Canadian Ingersoll-Rand manufacture in all of the mills. Of the 43 units installed, 42 are XVH units either direct connected or belt driven and of 1-stage construction. The other unit is a 50-hp ES-1 machine. There is a total of 9550 hp of vacuum pumps with a total capacity of 210,910 cfm at 24 inches mercury (Hg) vacuum.

In general the mills' compressor plants were designed for air requirements of 0.1 to 0.2 cfm per square foot of filter area and 1 cfm for each ton of contained solids in Pachuca tanks and agitators. For vacuum plants, a design factor of about 1 cfm of installed piston displacement for each square foot of filter surface was the accepted standard, without provision for stand-by equipment. Most plants have one vacuum pump on stand-by.

In addition to general mill-air requirements, a goodly quantity of air is utilized for control purposes. Temperature and pH controllers, flowmeters and weightometers as well as many valves depend on compressed air either for actuation or for governing signals.

PACKAGING

The granular uranium oxide is placed for shipment in standard 25-gallon (Imperial) drums. The drums are closed with a fully gasketed lever locking device and sealed with an imprinted lead seal for transportation to the uranium refinery. Like many industrial chemicals, U_3O_8 is poisonous and due precautions are taken to trap dust from the loading operation. Not only do employees in the packing rooms wear approved respirators as shown, but a complete dust collection system is installed in the hood of the loading hopper. As each barrel is filled, a small auger takes a continuous sample which is combined in lots representing so-many drums of oxide. This picture was taken in the Nordic drying plant which handles the Quirke output as well. The finished product from Quirke is transported in tank trucks to the Algom Nordic plant as a slurry.

sulphate complex. On further experimentation it was found that other ions in a leach solution obtained by treating certain uranium ores with acid were not too often selected by the resin to replace its original ions. Thus a means was found of selectively adsorbing the uranyl sulphate complex onto a resin base leaving the leach solution almost free of dissolved uranium. Even iron or ferric ions were not adsorbed; in previous extraction techniques, iron was by far the hardest element to separate from uranium because of its chemical similarity.

It was further discovered that by treating (eluting) the uranium-laden resin with a high concentration of chloride or nitrate ions in solution that it was possible to displace the uranium leaving it in a relatively pure solution. The resin was thus recharged for further use just as ion exchange water softeners are recharged. The eluate, or uranium bearing solution, may then be adjusted in pH value to cause the uranium to precipitate as U_3O_8.

There are a number of other important considerations in the application of ion exchange methods in metallurgy. One is that exchange does not take place instantaneously—time must be allowed for the pregnant solution to penetrate the tiny pores of the resin. Further, flow of solution through the resin, rather than just simple contact, speeds the process. It is also true that the more fully charged a given quantity of resin is, the slower it will pick up additional ions. It has been determined that for most economical handling of the resins, it is best to fully charge a column of the ion exchange material before eluting it. Thus it is that the uranium mills under discussion have several resin columns in series so that the first may be fully charged without suffering a leakage of uranium values.

When working with ion exchange, metallurgists must deal with the so-called resin poisons. These are ions of proper charge that so firmly attach themselves to the ion exchange material, because of greater electrical charge or other factors, that they cannot be removed by elution. Thus for every ion of poison, an ion of the desired substance is robbed of an attachment position. Eventually of course, such poisoning will make the resin useless for its intended work. Ion poisoning is not a great factor in the Algoma fields to date, however it has been encountered to some extent in South Africa. The poison is a cyanide-cobalt compound and is derived from the small quantities of cobalt in Union gold ores during the cyanidation process for gold extraction. The problem can be serious because as little as one part per million of the cyanide complex can cause an extreme case of poisoning.

Very fine grit can also "poison" or render useless an ion exchange material by plugging the pores of the tiny grains. This reduces the effective adsorption surface, thus cutting the number of desired ions that can be picked up by the resin. Grit plugging of resins is guarded against by careful vacuum filtration and clarification of the pregnant solution prior to passing it through the exchange columns.

COMPRESSED AIR power serves man in infinite ways to make his work easier. It also makes his life more pleasant by helping to fill the hours with music. A number of instruments, collectively known as the winds, depend upon compressed air for the sounds they make.

Sounding bodies are in a state of motion, although not always visible, alternately compressing the surrounding air molecules and rarefying them. This creates longitudinal air waves of varying shapes and sizes. Musical and unmusical sounds are the sense impressions caused by these waves. The former are created by one of three means: the beating of an elastic surface that is in contact with the surrounding air, as with a drum; the setting in motion of strings stretched through the air, as with a violin; or the regular breaking up of air columns enclosed in tubes or pipes of metal or wood. It is to this last group of sound producers that all woodwind instruments belong.

The regular breaking up of enclosed air columns may be caused by directly blowing at the end of a tube or across an opening made in the side, as is the case with a flute; by a single, beating reed—so called because the reed beats against a "table" at the upper end of the pipe—as in a clarinet; or by a double reed. (The last is formed with two sections that are bound face-to-face and held between the lips of the performer. Pressure from the lips and the breath causes the reed to vibrate rapidly, opening and closing the aperture between the two reed sections. The oboe is a double-reed instrument.) The last two

PHOTO, BRITISH EUROPEAN AIRWAYS

The Skirl Of The Pipes

S. M. PARKHILL

categories may be grouped under the name "reed woodwinds," and bagpipes are members of it.

Drones of a bagpipe, each producing a single, characteristic, constant tone, are like the clarinet, except that they have reeds of a very old type, being long, thin and tubular. Generally, the melody pipe, or chanter, is like the oboe, although its reed is broader and stiffer than that of the oboe.

There are many kinds of bagpipes, the essentials of which are the same. However, each variety has certain peculiarities of its own.

Bagpipes are the only indirectly blown instrument still in widespread use. They all have an air reservoir between the medium supplying the wind and the reed pipes; there is a space of about 1½ feet between the mouth of the musician and the reed of the chanter. The air bag serves the same purpose as the wind chest of an organ, that is, to provide a continuous supply of wind.

They differ from one another in size and their source of air. Some are blown directly by the musician who places his mouth over a tube, the blowpipe, that is inserted into the air bag. These instruments are the most familiar and are called "breath bagpipes." Others have bellows that are expanded and contracted by the motion of one arm, the other being used to exert pressure on the wind bag. The "bellows pipes" came into use, especially in France, during the bucolic court days of Louis XIV when it was felt that blowing directly on the pipes was undignified. The prime example of this instrument is the musette. It became smaller and more delicate in every respect than the breath bagpipes. Its tone and range were highly developed. Before it was refined to extinction in the eighteenth century, it was even wrapped in silk and velvet.

The reeds also vary—some being of the single-beating type; others, of the double variety like the oboe—as do the pipes' bores—some being conical and others, cylindrical. Generally, the Highland pipes' chanters have holes that must be covered with the fingers to produce the various notes; others are equipped with a key arrangement and produce a 16-note scale.

STANDING GUARD

High on the battlements of Edinburgh Castle Scotland, the piper at the left is of the Royal Highland Regiment, The Black Watch. He sounds the shrill pipes that once piped clans into battle. Today, pipers are a part of every Scottish regiment.

Only nine notes can be played on the unkeyed bagpipes. These are spaced on a tonal system that is not readily accepted by today's occidental music listener who is used to a musical scale that is based on what is called "equal temperament." This system is best illustrated by the notes of the piano, the forerunner of which instrument popularized well-tempered tuning; and the following table that compares the piano with the bagpipe.

	VIBRATIONS	
NOTE	PIANO	BAGPIPE
G	397	396
A	445 1/2	445 1/2
B	499	495
C #	559	556 7/8
D	592	594
E	666	668 1/4
F #	750	742 1/2
G	794	792
A	891	891

It is this slight variation, plus the constantly droning bass, that gives the bagpipe its eerie, Oriental sound. It is this difference too that has eliminated the bagpipe from most orchestral compositions, leaving it for solo, massed or rhythm-accompanied work only.

Because bagpipes do not mix readily with other instruments and because the instrument is exceedingly difficult to play well, the individual pipers became unique virtuosos. At one time, the soloists, or chief pipers, had great prestige in society. Each of the old Scottish clans had its own pipers who were led by a piper to the chief. His office was second only to that of the clan chieftan, and his position was hereditary. It was his responsibility to form a piping school for the clan. From it, pipers were selected for ceremonies and war. Because of the piper chiefs and their positions, the bagpipe became a part of the nationalism of Scotland and her clans, thus saving it from the near extinction it suffered in other countries.

In 1680, the MacCrimmons, who were pipers to the MacLeods of Dunvegan and the most famous in all history, opened a school for the training of pipers on the Isle of Skye. (Today, the people there still play the pipes upon the slightest provocation.) Livestock was the usual tuition. The course lasted 7 years, during which time each student mastered theory and memorized 195 compositions. Most of the natives thought that the young trainees should remain at school for 12 years, for they said that it took 7 years to learn to play the pipes, and seven generations to make a piper. If this is true, it is little wonder that there are so few piper chiefs today who are capable of being compared with the soloists of the old Highlands.

Edinburgh was the site of a revival of interest in the instruments that began in 1770. The movement spread and gained special momentum during the last century. Most of its concentration, however, has been on the massed pipers and annual contests. Many organizations have their bagpipe bands, as do most of the major cities in the United States and Canada. In Scotland, there are more than 1000 pipe bands. The skirl of the pipes, the swirl of the kilts, the flashing of sabers and the flying of ribands have universal appeal to the eyes and ears.

The exact origin of the bagpipe is unknown, although there has been much written speculation. Some is based upon references in ancient manuscripts; drawings on tomb walls; coins, statues, monuments and the like; and actual instruments, entombed with Egyptian mummies, that date to 1500 B. C. Although today the pipe is the national instrument of Scotland, it is known to have come from the Orient, probably carried westward by traders with the Persians, Egyptians and Greeks. References were made to pipers by Plato and Aristophanes.

The pipes first came under major refinements in the Roman Empire, according to some authorities, where drones similar to the ones used today were added. At the same time, the power and the shrillness of the chanter reeds were increased. To augment the air power, bellows were added. Some of these Roman instruments became large and elaborate, finally developing into the first, primitive organs. Thus the bagpipe is said to be the bridge between the Pipes of Pan, the syrinx, and the organ.

Nero, a notorious lover of music, was familiar with the pipes, according to Suetonius. His testimony is borne out by coins that were struck by Nero's treasury showing him playing a crude sort of bagpipe. Some of the more enthusiastic, although not always accurate, researchers claim that Nero played the pipes, rather than the fiddle, while Rome burned. Whether this is true or not, he and his soldiers are generally given credit for spreading the pipes through the Western world.

Bagpipes, of one sort or another, are found everywhere, are called by many names, and represent every stage in the development of the pipe. In Egypt, for example, the arghool consists of a chanter and a drone, positioned alongside each other; her present-day zummarah includes a wind bag. India's "snake charmer" pipes utilize a single-reed drone and a chanter, also side-by-side, fixed into a small gourd with a bit of wax. The scale differs considerably from that of the Scots bagpipe, yet the sound is much the same.

Bagpipes are used now, as they were since their beginning, as both a folk and a military instrument. In the former role, they are heard at religious services, all sorts of festive occasions, and the like. At one time, they even took the place of the organ in small churches.

During the Middle Ages, the pipes were thought to be beloved by fairies and hold a particular charm for animals. Some said the instrument was of the Devil and had the power of speech. Although they were used in the service of courts and city-states, they never lost this folk quality. Where they did, they became obsolete, as was the case of the musette.

As a military instrument, the bagpipe is often considered to be a psychological weapon of war that can be used to strike terror into the enemy and, at the same time, instill courage into compatriot hearts.

It was the pipes of the Highlands,
And now they played "Auld Lang Syne."
It came to our men like the voice of God,
And they shouted along the line.*

It is believed that the Highland pipes were first used in war in Scotland in 1314, at Bannockburn, when the Piper

*From Robert S. Lowell's "The Relief of Lucknow" (September 25, 1857)

PHOTO, BERN TOURIST ASSOCIATION

PERPETUAL PIPER

Sounding his instrument over a fountain in Bern, Switzerland, this piper serves to remind onlookers that the bagpipe is a universal instrument, found in one form or another in every country of the world. He is using an 8-hole chanter. The ancient belief in the power of the pipes over animals is reflected in the goose at the musician's foot.

MacIntyre was said to have piped for the forces of King Robert Bruce. Many braveries have been recorded about the Highlanders, and legends and songs are still heard that recall their prowess and, often, their great sadnesses. Through 400 years of war with England, the Scots suffered many defeats that are reflected in the greatest music of the pipes the Ceol Mor. To the people of Scotland, the music of the pipes is the sweetest when it is the saddest.

The Campbells Are Coming is a typical tune, and though not widely recognized as such, it is an Irish aire. It was transported to Scotland early in the eighteenth century during the Second Jacobite Rebellion of 1745, when the Scots attempted to return the Stewart kings to the English throne. The first reference to it is a letter in the *Wodrow Correspondence* dated April 11, 1716. The song brought hope and confidence to the oppressed and terror to the Jacobites. Recently, the pipers and the Americans were the first to land in Korea in 1950. As the 1500 Argyll and Sutherland Highlanders went ashore, they played *The Campbells Are Coming*, reflecting the long tradition of the bagpipes and the Scots. The American bands appropriately answered with *The St. Louis Blues*.

PHOTO, ARTHUR MAYNE LTD.

A COMPLETE SET

The bagpipes reproduced above show clearly the tartan-covered air reservoir; the three drones with their slide attachments for changing their single notes; the chanter, lying on the table in the foreground; and the blowpipe, the shortest member at the far left, for filling the bag. The completed instrument is adorned with streamers, cords, ribands, silver work and ivory.

MASSED PIPERS

Following ancient traditions of piping for festive occasions, the all-girl, bagpipe-and-drum corps of the State University of Iowa (right) recalls the use of the instrument at Roman circuses and, more recently, at Scots games. At the far right is a photograph of the massed dancers and regimental band of The Black Watch as they appeared at a recent performance in the U. S. They are a favorite performing group throughout the world.

It was at the urging of English ministers that the Highlanders were recruited to lift the spirits of the troops, the first regiment to be raised being The Black Watch, formed from independent Highland companies that date their history from the early 1700's. Others followed, and all have been a major part of the British armies, leading them to battle rather than following.

History tells of many accounts where the pipes have saved the day. During the Battle of Quebec (April 1760), the pipers of Fraser Highlanders were holding the front line against the French. After two assaults failed, General Wolfe, being an Englishman, couldn't stand the pipes' music, and ordered them silenced. The troops became restless, and as the third onslaught was about to begin, the general, upon advice from a Scots field officer, ordered them "to play up like the Devil." The pipes sounded, spirits rose and the line held.

During the eighteenth century, music of the Highland pipes was also keeping other rhythms than the military. Men building roads, launching boats and harvesting were kept in pace by the drones and chanter.

The Highland bagpipe has a valved tube leading from the performer's mouth to an airtight leather bag that generally measures 20x9 inches. It is held under the left elbow, the movement of the arm exerting the required pressure. This reservoir has five openings with one stock bound into each. These serve a double purpose, forming a protective chamber for the reeds and a coupling to which the drones, chanter and blowpipe are attached.

Drones are fastened to three of the stocks. There are either two bass and one tenor; or, one bass, a baritone and a tenor. Before the pipes are played, each is fixed in length to produce one tone by twisting or sliding it in and out. The longest is about 3 feet.

From the fourth stock, a 14¼-inch-long chanter is affixed. It can produce melodies in a 9-note range by covering and opening combinations of the eight finger holes bored into its length. (Two additional holes are added for regulating the pitch of the instrument, but they are never stopped.)

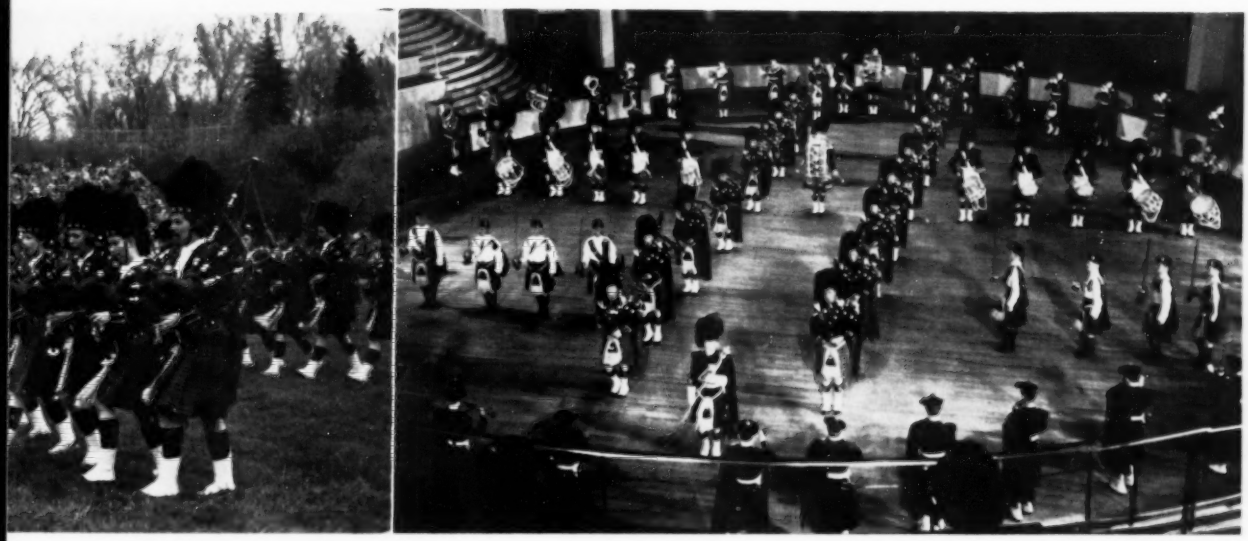
The fifth stock is attached to the blowpipe and contains a small leather valve. Thus, the air, when compressed by the elbow, must flow through the chanter and the drones.

With the exception of the blowpipe, each of the extending members is fitted with a reed. Some are made by splitting a length of cane, or reed, to the joint or knot from a cross cut made near the open end. It resembles the reed of an organ. The reeds are set downward in their respective chambers. The air, as it passes them, closes the formed aperture. As the pressure is decreased, the reeds spring open. This causes vibrations and produces waves through the bore of the drones, making the sound.

The chanter reed, like that of the oboe, is of 2-piece construction. It is laminated from thin cane, *Arundo donax*, and is known as a double reed.

By its nature, the bagpipe cannot be mass produced. There are some dozen makers in Scotland, and it is said that the finest pipes come from that country where its development and manufacture have reached their zenith. Two of the most famous early makers were Hugh Robertson (1775) and his daughter, who continued to bring fame to her family as late as the 1800's.

An average manufacturer produces about 200 full sets annually, in addition to about 600 practice chanters and a great number of repair and accessory parts. These are sent to retailers throughout the world. Hugh MacPherson is a typical example. His firm has been in operation for more than a quarter of a century, and its shipping records indicate that pipes have been sent to all the English-speaking countries of the world, as well as to many in the Far East and



PHOTO, S. BUROK

Europe. One of its most unusual orders was for 25 sets to be sent to Vajuravudh Native College, Bangkok, Thailand, for it returned the bagpipe to the area of its probable origin.

The finest quality pipe is made of African blackwood, imported from Tanganyika Territory, East Africa. It is used because it is very dense and has a high musical quality. The wood contains a natural oil that preserves it, an important fact considering that bagpipes are sold throughout the world for use in widely varying climates. Other woods used, although less satisfactory, are Partridge, Cocox and black ebony.

Trees varying in diameter from 18 to 24 inches are selected and cut into 5-foot sections. After cutting, the logs must be cured for 6 or 7 years.

The seasoned wood is then halved by hand and cleaned of the sand it often contains. Next the pieces are cross cut on a circular saw into various-sized billets, and squared.

Rough turning and boring follow. When finished, the crudely shaped pipes are again aged to assure that all the parts will retain their correct bore (a standard tapered bore today) and will not shrink or warp when exposed to the weather. The fourteen parts that are required for one set of pipes are now recognizable as far as their lengths are concerned.

The rough-turned, rough-bored sections are given to individual craftsmen who complete the work on lathes. Each is responsible for mounting the various ferrules, projecting mounts, ring caps and the like, whether they be of wood, metal, ivory or silver.

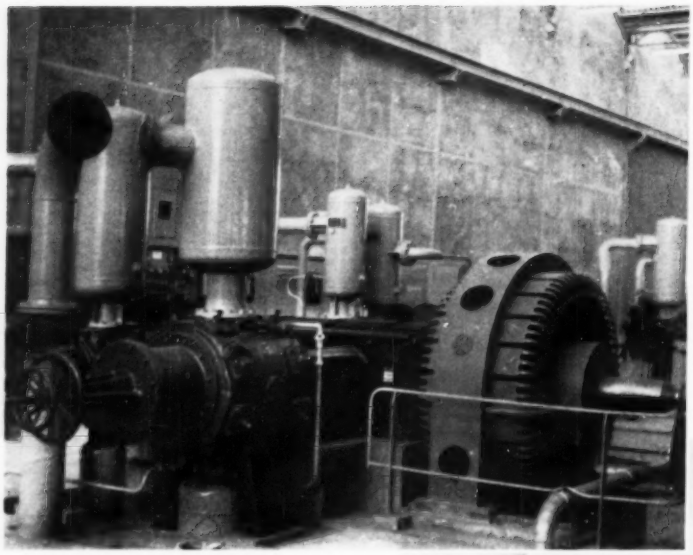
All pipes of African blackwood have the same tonal quality independent of their price. The difference in cost lies totally within the ornamentation. For example, a set with imitation ivory costs nearly $100 in Scotland, while one with ivory retails for approximately $150. The same in mounted and hallmarked, chased or engraved silver is more than $325.

The ornamented pieces are then sent to another craftsman who attaches a sheepskin or goat bag to the pieces, and covers the skin with a second bag of woolen tartan.

In the final instrument, there are wood and ivory from Africa, silver from Canada, reed from Spain, sheepskin from Scotland, cords and tassels from England, and cloth manufactured in Scotland from Australian wool. International as the bagpipes are, both in their construction and use, their music, of course, remains essentially Scottish.

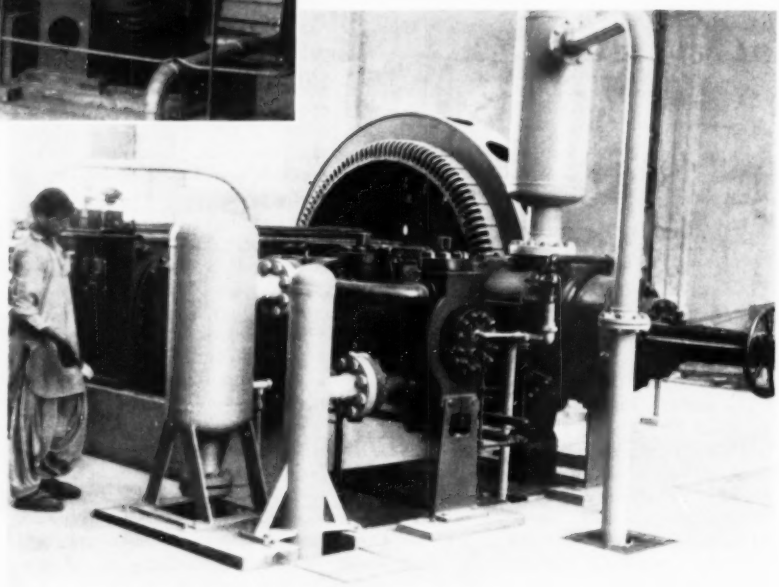
PATIENCE AND WIND

At the left, the piper is tuning the chanter to the proper pitch. The drones and bag have been removed and the chanter itself is placed in the performer's mouth. With his lips around the reed, the lungs are required to act as the air supply and reservoir combined. The other two illustrations show the slides on the drones being adjusted to their proper notes. The illustration at the right shows clearly the kidney-shaped bag reservoir, the three drones protruding upward, the blowpipe from the mouth to the bag and the chanter hanging downward in position.



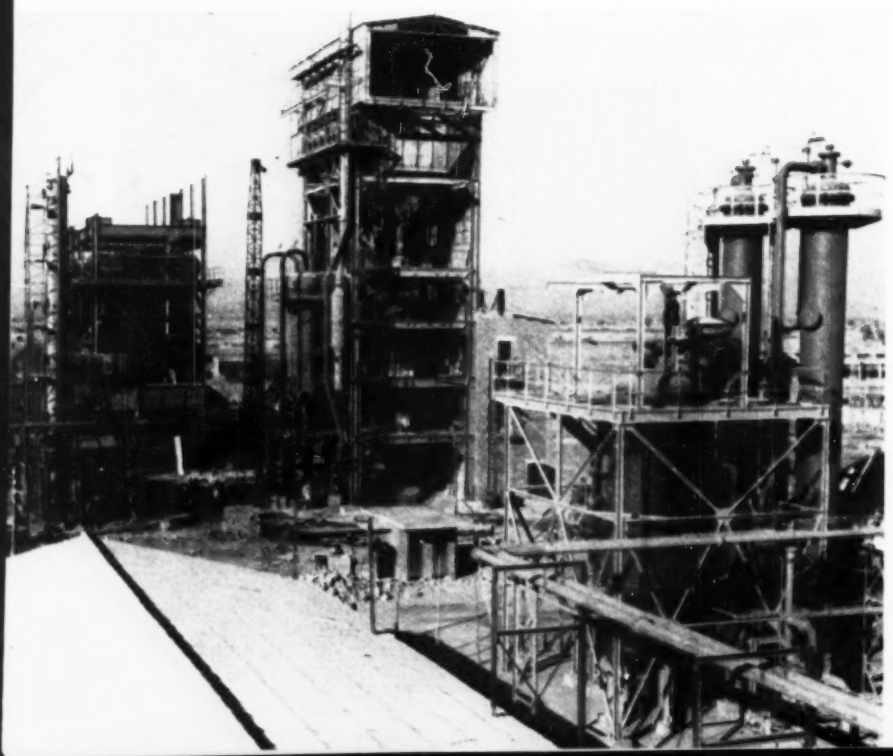
NITROGEN PUMP COMPRESSOR

At the left is shown one of a pair of 12-inch stroke, 6-stage compressors used to develop 2940-psig pressure in the nitrogen stream of the Daud Khel fertilizer plant. Equipped with special pulsation bottles on both the inlet and outlet of each stage the unit is driven by a 600-hp synchronous motor at 375 rpm. The first-stage cylinder is the one in the view. At the time the photograph was taken, the suction piping was open to atmosphere to enable the machine to pump air on the run-in and trial tests. These units are also of Ingersoll-Rand manufacture.



SYN-GAS COMPRESSOR

On the basis of 100-percent stand-by capacity in the remote Daud Khel area of Pakistan, two units of the type shown in this illustration were installed. The machine selected for this service by U.C.B., is an Ingersoll-Rand 3HHE-4 compressor handling synthesis gas in four stages. It has a rated discharge pressure of 9300 psig. With a 14-inch stroke, the machine revolves at 257 rpm driven by a 1500-hp General Electric synchronous motor. Power for all compressor drive motors is furnished at 6250 v, 3 phase, 50 cycles — a power factor of .9. The first-stage cylinder is at the right; the second stage, left; and fourth and fifth stages on the opposing side.

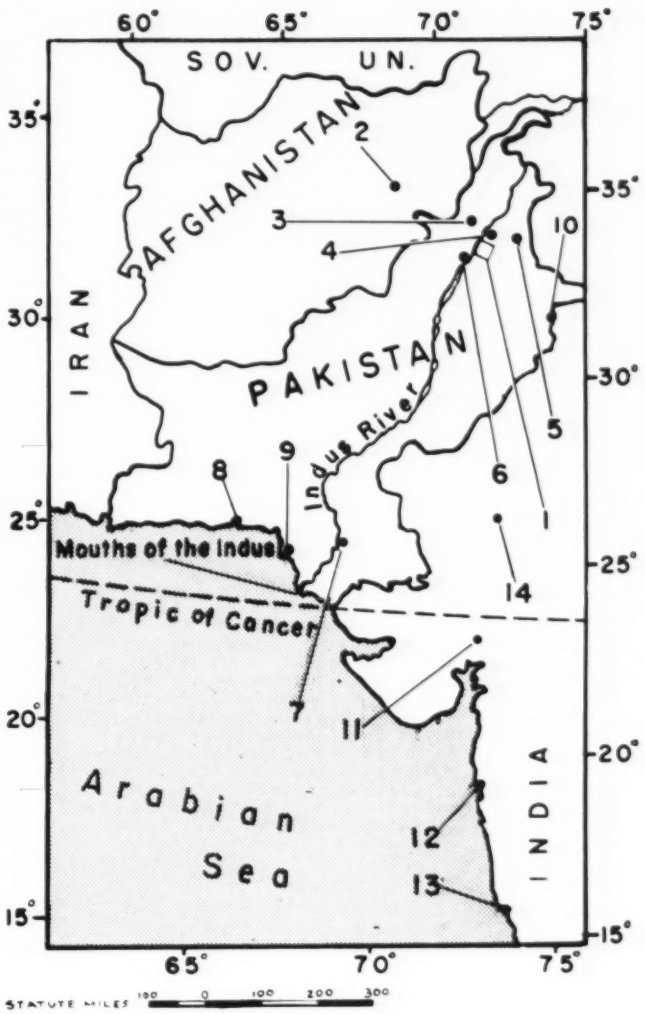


UNIT PROCESS EQUIPMENT

Left, in the picture at the left, is shown the Babcock & Wilcox boiler supplying steam to the fertilizer plant. In the center is the Lurgi coal gassifier which is the basic unit of hydrogen supply. The equipment at the right is the carbon monoxide conversion unit in which carbon monoxide from the coal gassifier is oxidized to carbon dioxide. Dissociation of steam under high temperatures and pressures supplies the oxygen for the step and also releases large quantities of hydrogen.

REFERENCE MAP

Daud Khel (1) is the site of the fertilizer plant discussed. Other cities in the area of West Pakistan indicated include Kabul, in Afganistan (2); and Peshawar (3), the one-time capital of the North-West Frontier Province near the entrance to the Khyber Pass; Campbellpur (Campbellore) (4); Rawaphildi (Rawalpindi) (5), once the largest British military station in India, and about 100 miles from Peshawar; Makarwal (6); Hyderabad (7); Kanrach (8); Karachi (9); and Lahore (10), notably the hottest place in all India and Pakistan. In India, the numbers refer to Ahmedabad (11), Bombay (12), and Jodhpur (14); and Nova Goa, Margao, Karwar in Goa (13).



R. W. SAPORA

Initial steps in an all-out effort to feed her hungry millions have been taken by Pakistan with the construction of a plant to make—

FERTILIZER

FROM COAL AND GYPSUM

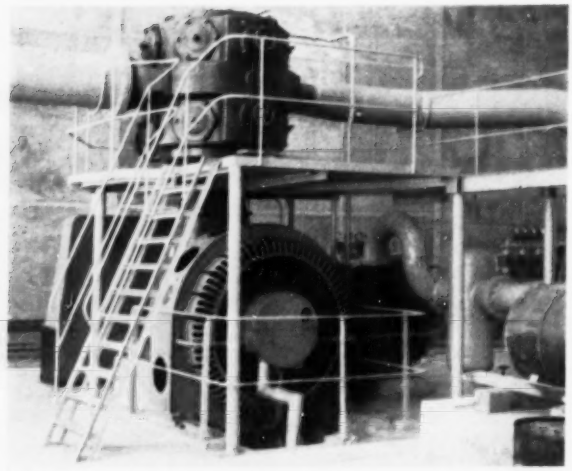
PAKISTAN needs fertilizer to maintain and increase the productivity of its land. Extensive reclamation projects are making the need even more acute. In the southern province of Sind, for example, about 5,500,000 acres now under cultivation were formerly desert, and have been reclaimed by irrigation. An ammonium sulphate plant at Daud Khel in West Pakistan is the first of several fertilizer factories that will be required to meet the country's needs. Covering an area of 225 acres, the plant converts coal and gypsum to 50,000 tons per year of fertilizer.

One hundred twelve tons of coal per day from the nearby Makerwal Collieries are integrally gasified under pressure by the so-called Lurgi process. Utilizing steam and oxygen in the gasification of coal, the process yields a synthesis gas (syn-gas) rich in hydrogen, great quantities of that element being added by the dissociation of the steam. Syn-gas output is at the rate of 260,000 cubic feet per hour.

The output from the gassifier is first washed with water and separated from tars. Then, a washing with oil is utilized to remove liquid hydrocarbons. Sulphur is partially removed by selective water washing, under pressure, yielding hydrogen sulphide (H_2S). This by-product serves as raw material for a wet-contact plant that produces 7 to 14 tons per day of sulphuric acid, which is later used in the ammonium sulphate conversion process.

The cleaned syn-gas undergoes a second desulphurization and is then sent through a carbon monoxide conversion operation. The CO component of the gas is oxidized to CO_2, oxygen being supplied by the dissociation of steam at high temperatures and pressures. Additional hydrogen from the steam is thereby added to the syn-gas. After a final desulphurization, the CO_2 content is removed by a decarbonization process in a water washing plant followed by a caustic soda washing. Finally, methane, remaining carbon monoxide, and argon are stripped from the hydrogen by washing it with liquid nitrogen. Pure nitrogen for this step is furnished by an air fractionation plant that also supplies oxygen required for the initial gasification.

The resultant pure stream of hydrogen is combined with one of nitrogen in the proper proportions, put under high pressure and then reacted in the presence of a catalyst to form ammonia.

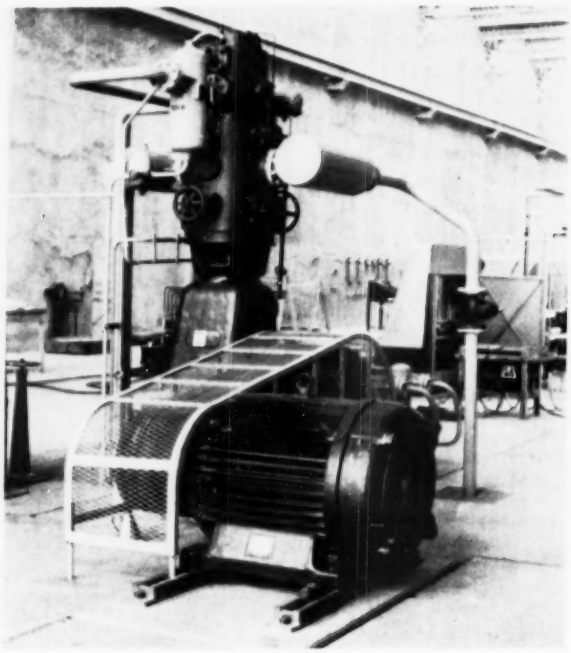


HIGH-AIR REFRIGERANT

In the unit at the right, and two others like it, air is compressed to 2940-psig pressure and used for two purposes. Upon cooling, nitrogen liquefies and the fluid effluent is used for washing the desulphurized and decarbonized syngas stream. The high-pressure air is also cooled by expansion in the fractionation plant and, counterflowing a stream of incoming low-pressure air, liquefies it as the first step in the production of the pure nitrogen stream which is combined in the synthesis plant with hydrogen to form ammonia. The oxygen product of the fractionator is utilized in the gassification process, as detailed in the text. The compressors are Ingersoll-Rand Company XVH-4 units of 10-inch stroke. Of "L" design, they have tandem cylinders resulting in four stages of compression. Each is driven by a General Electric 150-hp belt-connected induction motor. During plant start-up, all three machines are in operation to speed cooldown of the fractionation plant. In normal operation, only two of the compressors are required.

AIR FRACTIONATOR SUPPLY

One unit of the type shown in the illustration at the left is at work in the Daud Khel plant, with a second on order. It supplies air to the fractionating plant which supplies nitrogen and oxygen to various processes as outlined in the text. The machine is an Ingersoll-Rand XVH-unit with a 15-inch stroke. It is driven by a General Electric 700-hp direct-connected motor at 333 rpm and delivers 4000 cfm at 85 psig.



The synthesis plant has an output of 40 tons per day of ammonia.

The end fertilizer product of the plant, ammonium sulphate, is manufactured by reacting ammonia, gypsum, CO_2 and sulphuric acid. The carbon dioxide stream comes from the gas decarbonization plant; gypsum is obtained from a neighboring quarry; and the required sulphuric acid, from the wet contact plant already mentioned. Fertilizer output (an average of 150 tons per day) is bagged in a 40-ton-per-hour facility or bulk loaded at the same rates.

Since the factory is located in a non-industrial area, facilities for all the general services had to be provided. A 20,000-kw steam power plant was built. (Its boilers burn pulverized coal, as well as tar and oil produced during gasification steps, and gas from nitrogen washing.) Steam is extracted from various stages of the turbine for manufacturing.

Water for the power station, and the factory in general, is obtained from a series of filtering wells, about 3 miles away and on the banks of the Indus River. It is forced to the factory by a pumping station having a discharge capacity of 300,000 gallons per hour.

Storage is provided for a reserve of 5000 tons of gypsum, enough to last about 25 days; and for 16,000 tons of sulphate, enough to last about 3 months. Coal reserves, totalling 5000 tons, are kept in an atmosphere of nitrogen.

The factory includes a maintenance workshop equipped with numerous modern machine tools, a supply of spare parts, and maintenance and handling equipment of every type. Modern offices, laboratories and recreational facilities complete the installation.

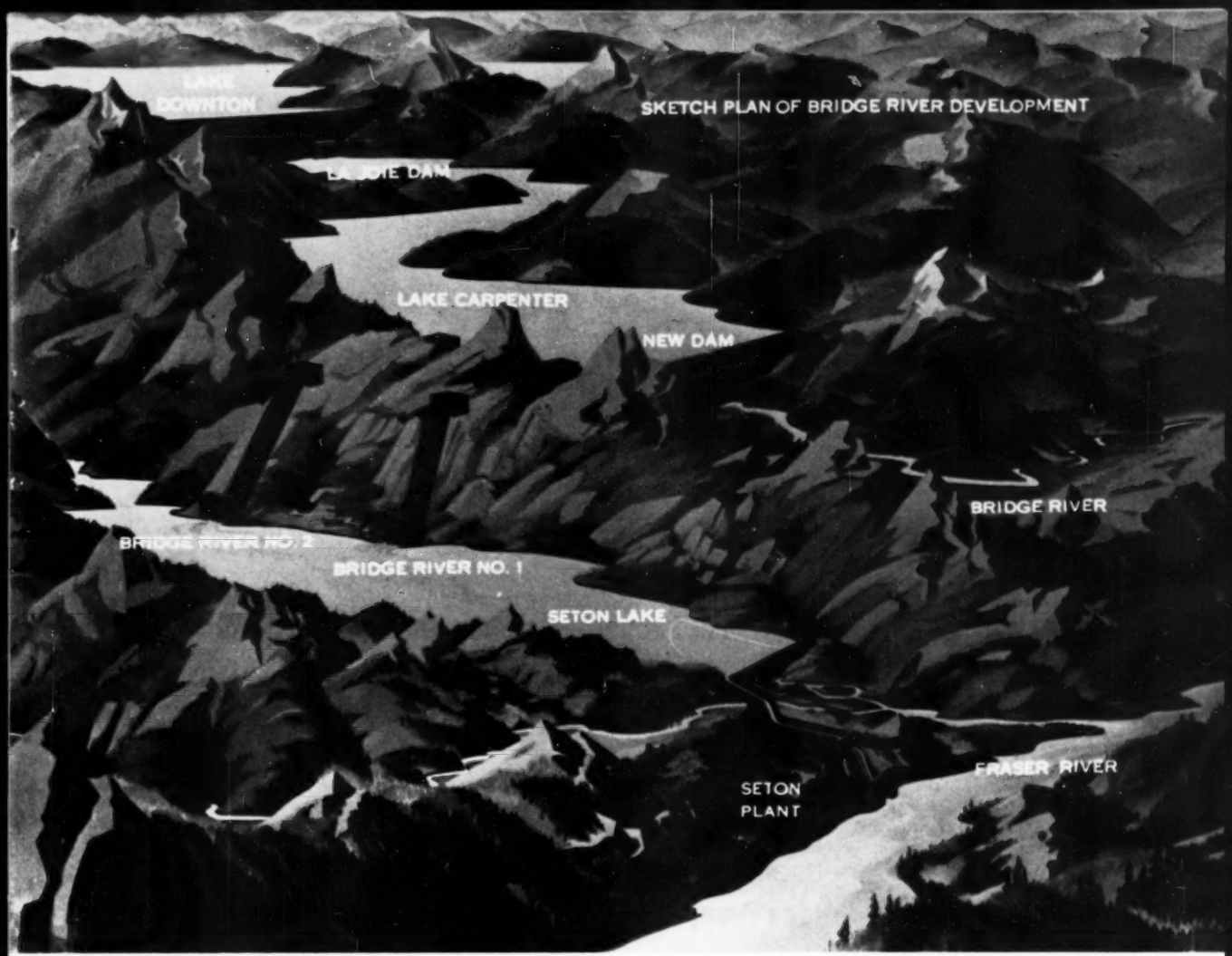
All manufacturing units have been designed to permit eventual doubling of production. To insure uninterrupted operation of the entire installation, stand-bys have been provided for certain units, among them a gas producer, compressors and a power generator.

With the exception of a few foreign specialists, the factory is operated entirely by Pakistanee technicans and personnel who, for the most part, were trained in Belgium by Union Chimique Belge (U.C.B.), consulting engineers for the project. The output figures mentioned earlier in the article are those that are guaranteed by Union Chimique. It is expected, however, that as soon as the Pakistanees are fully trained, the figures will be up 10 to 15 percent.

U.C.B. received its contract in November 1952 from the Pakistan Industrial Development Corporation, (P.I.D.C.). Original negotiations for the facility date from August 1947, immediately following the partition of Pakistan from India. These meetings led to the dispatch by U.C.B. of a study mission to Pakistan in November 1949. Discussions continued after 1950 with the newly established Pakistan Industrial Development Corporation, and in March 1952, after U.C.B. submitted a detailed report, P.I.D.C. awarded the construction contract. The project was sponsored by F.O.A., the Foreign Operations Administration. (This was the predecessor of the I.C.A., the International Coöperation Administration.) A contract for additional fertilizer factories was awarded to U.C.B. in April 1955.

The relationship of U.C.B. and P.I.D.C. is not, however, limited to the design and construction of fertilizer plants. Another contract calls for the construction of two pharamaceutical products factories, the first in West Pakistan and the second in East Pakistan. In addition, U.C.B. has submitted plans to P.I.D.C. for the construction of a tar processing plant, a foundry, an ossein* and gelatin factory, and a rayon factory. Further, it has made preliminary studies for a caustic soda and sodium carbonate plant and a glass works.

*Ossein is a protein obtained upon the removal of mineral matter from bone tissue.



POWER SYSTEM

This drawing shows existing and proposed hydroelectric development at British Columbia Electric's Bridge River power project and its satellite Seton Plant. Mission Dam is being built at the site marked "new dam," where a grouting technique new to North America is being applied in stabilizing a porous sand and gravel underlay. The water to be held back by the structure will flow through tunnels to existing Bridge River No. 1, and to No. 2, now under construction, to generate a total of more than 500,000 hp.

Sealing A Sieve

A Versatile Grouting Process Binds A Porous Dam Site

G. R. SMITH

AS THE glaciers of an ice age long past groaned slowly southward through what is now the heart of British Columbia's coastal range, they scored a long furrow into the area's granite bedrock. Much later, when the climate warmed and the ice began to melt, the granite sluice was there waiting, a natural channel. The ice continued to recede as the melting became more vigorous, and the glacial incision received the increasing water flow and grew to be a river. When the area was finally occupied by man, the stream in British Columbia was named Bridge River.

Today the river is the source for 248,000 electric horsepower supplied to the British Columbia lower mainland from British Columbia Electric's Bridge River No. 1 generating station. The construction of the company's second power plant, which will add some 345,000 hp to the generating system, will be completed in 1960. Four 62,000-kw generators will be installed in the new powerhouse by Canadian Westinghouse Company.

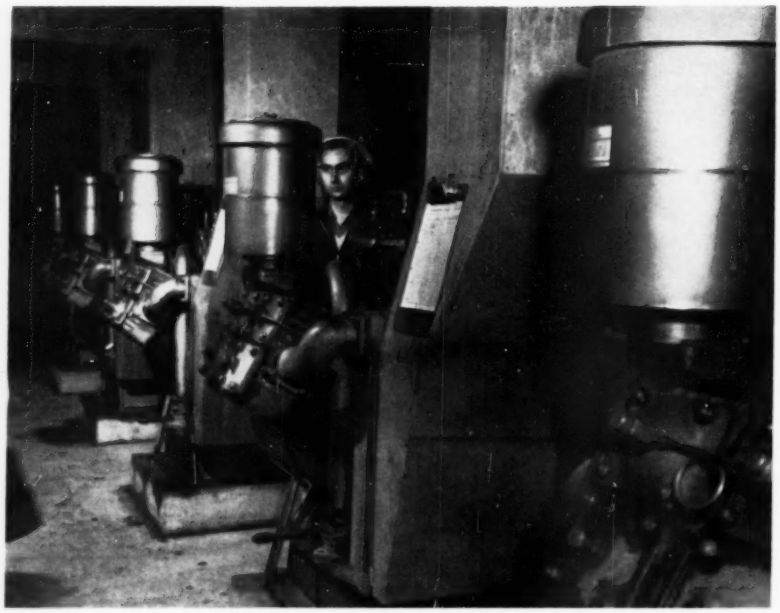
The existing station was started in the late 1920's but full development was curtailed due to the depression, and later, due to World War II. Following the war, extensions were made to the

project, bringing it to 248,000-hp capacity by 1956.

This earlier project includes LaJoie storage dam, 282 feet high, a smaller diversion dam, a 2½-mile tunnel under Mission Mountain and a powerhouse on the shore of Seton Lake. LaJoie Dam impounds Bridge River water for regulated year-round runoff. This is necessary because the spring flood on the river is about 25 times greater than the low runoff period. The diversion dam directs water into the tunnel under Mission Mountain. From the tunnel, water drops 1200 feet through 6-foot-diameter penstocks to the powerhouse on the shore of Seton Lake.

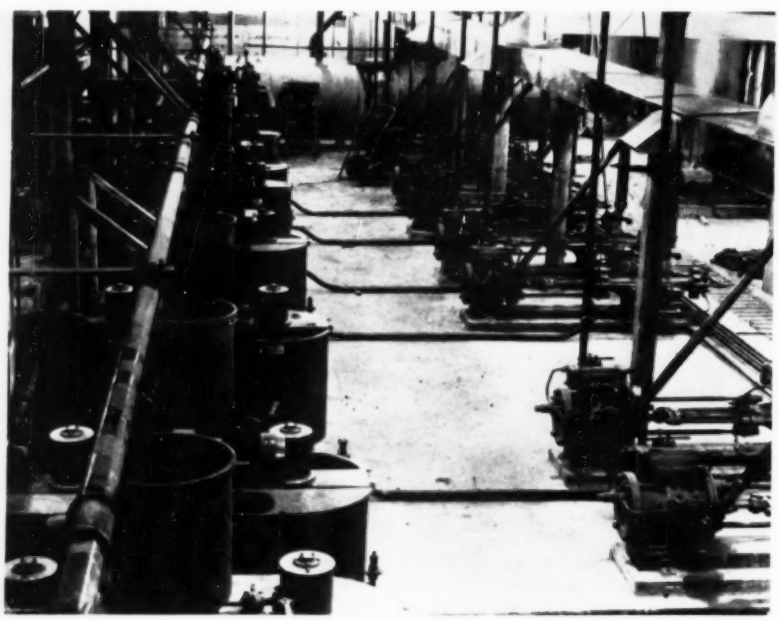
Bridge River Station No. 2 follows the same principle as No. 1, and its powerhouse will be located ½ mile west of No. 1. In all, the new project will consist of the powerhouse, penstocks, switchyard, a second major tunnel through Mission Mountain, and a 180-foot-high dam being built 45 miles downstream from LaJoie. The new earth-fill Mission Dam will be about 1000 feet thick at the base and 1200 feet wide.

Mission Dam is being constructed on a site where a unique grouting process is being applied, a type never before undertaken in North America. In this particular area, the rock furrow cut long ago by glaciers eventually filled with a porous sand and gravel layer nearly 500 feet deep. This lies below the river bed, and construction of Mission Dam on this pervious layer would have been futile. Water stopped-up by the dam would filter down through the sand and gravel to escape. For this reason it was decided that the river bed must be grouted.



VITAL AIR SUPPLY

The air pressure which goes into the grouting pumps is supplied by these five Ingersoll-Rand Type 40 air compressors. The 2-stage air-cooled units each supply 445 cfm of air at 100-psig pressure.



GROUT PUMPS

The horizontal units at the right are the Italian-manufactured grouting pumps that force grout underground using air pressure. Grout mixing tanks are in a line in the left portion of the picture, and in the far background can be seen several large water tanks. Air at 100-psig pressure is used to transfer the water in these tanks to the grouting equipment.

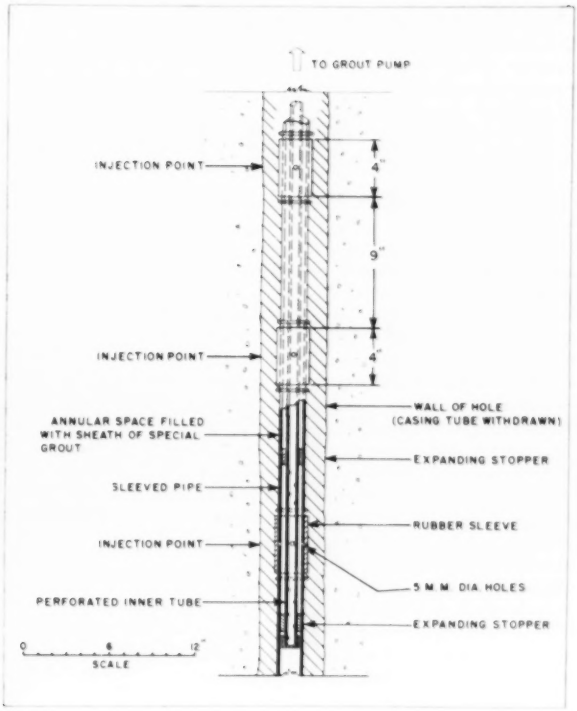
Normally, dam grouting—the blocking of escape routes beneath a dam site—is carried out with cement as the grouting material, because a dam bed usually consists of fractured rock. Cement fills the cracks between the rock, stopping water flow by sealing off downward escape routes. Cement, however, is unfit for grouting a sand and gravel layer such as the one that lies beneath the site of Mission Dam. Instead of completely filling the tiny openings between the particles of sand and gravel, as a successful grout must do, cement tends to superficially plug these passageways. It doesn't create a solid mass, but only a weak, honeycombed one, unable to prevent the reservoir water from passing through.

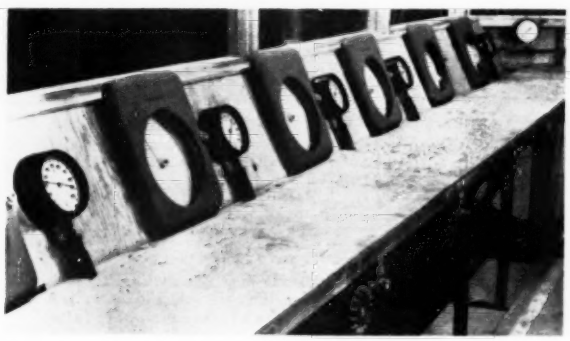
The unusual grouting process being used is a development of a French group of grouting specialists, Soletanche & Associates, whose representatives were called to British Columbia especially for the job. The Soletanche system has been highly developed in Europe where it has been applied chiefly to dam foundations. It also has been used for stabilizing walls of tunnels and the foundations of bridge piers built in midstream.

Forced into the ground under high pressure, the grout is composed of one or more of these materials: rock flour, cement, clay, and chemicals such as silicate. Each grout is designed for a particular installation, and though it very often consists of a mixture of cement and chemicals in a clay base, occasion-

GROUTING TUBE

This sketch is a side view of the device used for forcing grout into the soil. Essentially, the unit consists of an outer tube and a movable inner tube which are inserted into a drilled ground hole. The inner tube is closed on the lower end. Several perforations near the end are isolated within the outer tube by sealing stoppers, one above and one below the perforations. Grout is pumped into this isolated area. It passes through holes in the outer tube which are spaced each vertical foot. (The inner tube is moved up and down to rest opposite the single set of holes desired.) The grout then forces its way through a special sealing grout to make its way into ground fissures. A casing is put into the ground hole when it is drilled, but removed immediately after the outer tube is inserted and the sealing grout put in.





CONTROL PANEL

This control panel keeps continuous surveillance on the grouting operation. Grouting pressures are indicated on the dials while the pens inscribe a permanent record of the work's progress. Valves below the panel's plywood counter are turned to adjust pressure.

ally the material is almost entirely cement or clay. In some cases only chemicals are used. The nature and texture of the ground govern the composition. The process is not secret, but the French specialists have an advantage created by their long and precious backlog of experience.

The method for forcing the grout into the soil is equally unique. In treating a dam site, the first step is to bore many holes of a few inches diameter into the ground to be stabilized. At Mission Dam 125 holes of 5⅝-inch size were put down to depths of 500 feet. These holes pass through a clay stratum that lies atop the porous sand and gravel. The clay layer, varying in thickness from about 50 to 80 feet, has a depth of 40 feet below the river bed at this point.

In the Soletanche process, a casing that is only slightly smaller than the diameter of the hole, is first set into the hole. Into this casing goes a tube of about 2½-inch diameter having radial perforations each vertical foot; these holes are sealed by external rubber sleeves that fit closely around the pipe. When the perforated tube is in place, the casing is removed and the annular space quickly filled with an extraordinary grout that forms a watertight seal. The grouting tube (of about 1-inch diameter) is then inserted into the sleeved line. The bottom end of this tube is closed and near the end of its lower tip is a small perforated section or grout nozzle. Above and below this perforated belt are expanding stoppers that press tightly against the outer tube to isolate and seal the nozzle.

The inner tube with its stoppers is raised or lowered to rest at a point opposite the desired sleeved hole in the outer tube. When grout is pumped through the inner tube, it fills the isolated area and squeezes through the perforations and rubber sleeve of the outer tube. It then punctures the special waterproof grout and passes into the soil fissures.

As is normal, grouting at Mission Dam began at the bottom of the hole and progressed upward at 1-foot intervals. Because the inner tube can be moved up or down, however, grouting is possible at any height within the hole, while omitting higher or lower elevations. For instance, before work began at an electric power plant site in the Rhine River Valley in Europe, the earth to be excavated was isolated from ground water. A grout curtain was injected to the sides and in a separate long horizontal layer far below the excavation site, forming a sort of tank or shell around the excavation.

The grout pumps at Mission Dam operate using 100-psig pressure air supplied by five 445-cfm Ingersoll-Rand Type 40 air compressors. These are 2-stage, reciprocating, air-cooled units. The project has a definite international aspect, as the French concern's grout formula is injected into the Canadian soil by use of ten high-pressure grouting pumps of Italian manufacture, operating on air supplied by American-built compressors.

To compensate for water percolating downstream diagonally into the river bed, the grout curtain is being injected slightly upstream from where the dam is actually being built. This also avoids interference with the dam construction. An impervious wall of sheet piling has been inserted downstream of the grout to more completely cut off water escape above the clay stratum.

The contract for the $25 million dam (the entire power project is to cost $56 million), was awarded to Northern Construction and J. W. Stewart Limited. Design, contract and supervision is being carried out by B. C. Engineering Company Limited. The contractors have another ticklish problem to solve—this one created by the clay layer immediately under the river. It is estimated that because of its great weight, the completed dam will eventually settle about 15 feet into the soft clay. This is not an immediate process and must be taken into account. To compensate for this downward movement, a sizable bulge will be built on the structure's upper surface. When the clay finally settles, the bulge on top of the dam will flatten to a nearly level position.

AN AIR-CONTROLLED—

Bin For Grocery Boxes

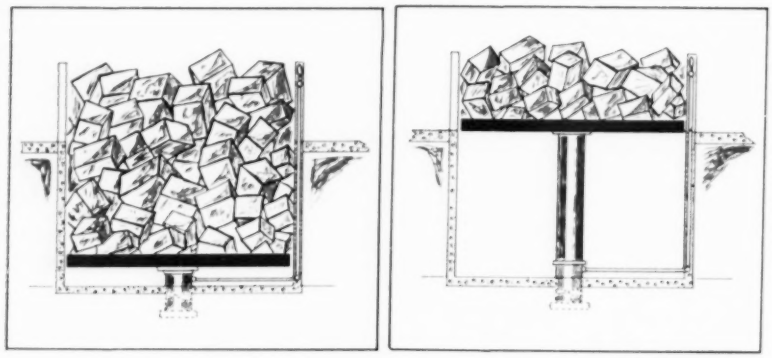
A FAMILIAR sight to supermarket shoppers is the unattractive accumulation of cartons piled high around store check-out counters. No matter how modern the shopping facilities or the decor of a market, it seems the forward window area always is cluttered with boxes that once contained soup, soap, vegetables, sugar, flour, etc. Although they distract from the tidy appearance of the stores, the cartons are an absolute necessity for packaging the larger, outgoing orders. For example, an inspection of one market on a busy Thursday night disclosed 110 of these boxes scattered in a 25-foot-long heap.

For one West Coast supermarket, however, this problem has been solved by the use of an air-actuated platform lift, manufactured by Globe Hoist Company. The Box-Bin lift, as it is called, has a 5x10-foot rectangular platform raised from below by a 10⅝-inch-diameter, air-controlled hydraulic cylinder having a 70½-inch stroke. The pit has a depth of 6½ feet below floor level. At the beginning of the day, the lift is placed in the down position and filled with empty cartons. As the supply is depleted, a grocery clerk periodically opens an air control valve to raise the platform. This elevates the box pile so that it is always at a convenient level.

The pit is enclosed by a plywood wall covered with laminated plastic that matches the color plan of the supermarket. The air valve that controls the lift cylinder is located in a channel outside this plywood enclosure. A 12-inch section of the railing top has a piano-hinged door that opens to allow access to the control lever inside.

The Box-Bin has a maximum capacity of approximately 450 cubic feet of boxes; it requires only 50 square feet of floor space. The unit is installed at the midpoint of a battery of check-out stands and provides several advantages. It holds approximately 125 boxes handily and eliminates the cluttered appearance of a naked box pile. It blends nicely with other furnishings of the market. Its boxes are continuously available within comfortable reach, and those cartons that are temporarily rejected can be put aside without being thrown helter-skelter about the front of the store.

The air-actuated device aids the supermarket in its bid for customers in the highly competitive grocery business. Its convenience provides customer good will and encourages store acceptance.



BOX-BIN'S USE

At the beginning of the day, the lift is filled with cartons as shown in the left sketch. As the boxes are needed for use in carrying groceries, they are taken from the bin. Then, to put the remaining cartons within easy reach, the hydraulic cylinder raises the platform higher, as seen in the right sketch.

RAISING BOXES

Lifting a hinged door, this grocery clerk reaches inside to actuate a valve that controls the raising and lowering of the bin. The carton container eliminates clutter in the supermarket and blends with the store's attractive interior, while providing convenience.

This And That

"Rubber" Of Many Properties

Estane VC is a tough, resilient, unvulcanized material that resists tearing and the effects of abrasion, solvents, oil and ozone—unique properties for rubbery material. It is a plastic-type substance that snaps like rubber, yet, unlike rubber, works without vulcanization. The U. S. Patent Office has granted The B. F. Goodrich Company a patent on the invention of this new material, and already many uses are being found for it. Most unusual of these is in the development of plastic hearts and heart valves. Its toughness, flexibility, freedom from additives to leach out, stability in blood and plasma and acceptance by host tissue, make it useful not only for the heart structure itself, but also for the valves and artery grafts. Other potential uses include fuel hose, small-bore tubing, belting, coated fabrics, equipment linings, engine mounts, valve diaphragms, pump components, and insulators.

The VC in the name is an abbreviation for *virtually cross-linked;* that is, the hooking together of large molecules accomplished in most natural or synthetic rubbers by vulcanization with sulphur. The molecules in Estane VC can be easily unhooked by heat or solvents. Thus, it can be used in solution or to deposit films which, when dry, have the properties associated with vulcanized materials. In this film form, it has a tensile strength of 7000 to 8000 pounds per square inch.

* * *

Petroleum Industries' Lake Boats

A new type of stainless steel strut-and-rudder unit is being used on special boats for the oil industry in South America to quicken and improve their maneuverability. The 52-foot-long boats are required to turn and twist quickly in the brackish waters of inlets and along the coast, much like quarter horses in rounding up cattle. The new design of the strut-and-rudder combination was conceived by marine architect Philip Rhoades; it was cast of Type 316 stainless steel by Allegheny Ludlum Steel Corporation; and H. Paasch Marine Service Company built the boats. Because of the unusually corrosive conditions of the waters which are heavily laden with salt and chemicals, stainless steel was selected. Previously, a softer metal was used, but often had to be replaced. It is expected that the new struts and rudders will outlast the boats themselves. The strut is made in a casting of 60 pounds; and the rudder, in a casting of 110 pounds. Two each are used on one boat. Labor and material costs were held to a minimum because the items were cast in one piece rather than being fabricated of many smaller sections. The boats, seven in all, will be used to haul equipment and transport personnel.

* * *

Ultrasonics—An Industry To Watch

An industry currently standing at its threshold of activity is ultrasonics. This term refers to the use of sound waves with frequencies beyond human audibility—about 20,000 cycles per second and higher. Ultrasonics is used to describe all applications of sound energy to industrial processes, although many ultrasonic devices have frequencies within and below audibility. One application for a high-frequency device is an ultrasonic dishwasher that works at about 40,000 cps; such a machine has been displayed by Narda Ultrasonics, Westbury, N. Y. Although the company reports that the dishwasher is not quite ready for the market, production is expected to begin later this year. Known as the Vanguard, the Narda household dishwasher is a mobile unit that can be plugged into any 110-v electric outlet and hooked to normal household plumbing. It uses normal dishwashing detergents and tap water. The high-frequency waves emitted by the device alternately compress and decompress water in the sink. This causes myriads of tiny vacuum bubbles to form and then collapse with tremendous force, shaking loose all material from the dishes or utensils being washed. Such traditionally stubborn food particles as fried egg, hardened sugar and coffee residues in the bottom of the cup wash away without manual encouragment. Outside the kitchen, ultrasonic instruments are useful for hospital, military and industrial cleaning and degreasing. The aircraft, electronic and missile makers have spurred the young industry's growth, one use being the cleaning of jet-engine nozzles and oil filters. Other industrial uses include units for inspection applications—nondestructive testing, thickness gauging and flaw detection; units for chemical processing, deaerating of boiler feed water, die and mold shaking, remote control of TV sets and garage doors, and water signaling and navigation.

* * *

Boon For Operation Bootstrap

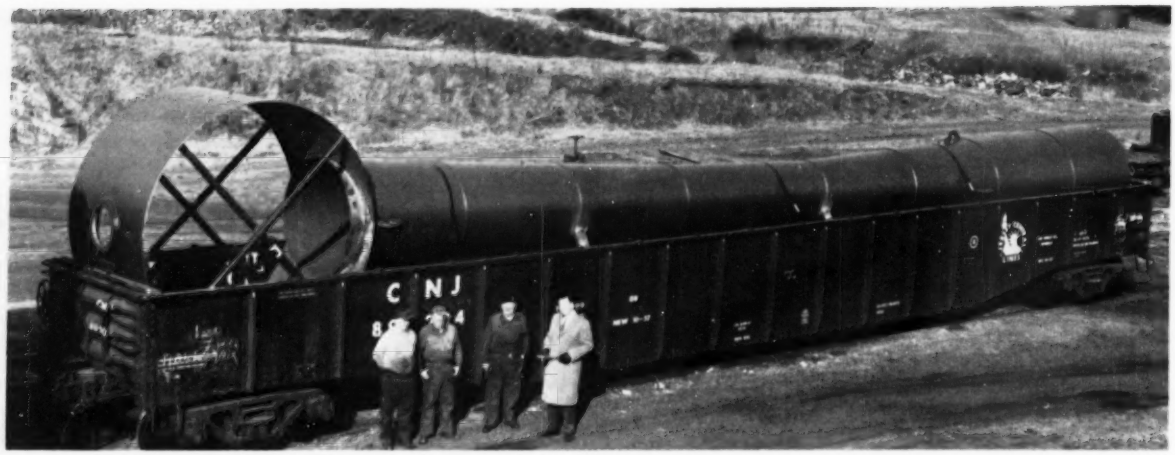
The well-publicized Operation Bootstrap in Puerto Rico received a substantial lift recently when F. A. Hildebrandt and R. J. Smith, geologists working for the country's Economic Development Administration and the United States Geological Survey, discovered commercial-sized deposits of four useful minerals: pyrophylite, alunite, kaolin and quartz. The first is a component of insecticides, fungicides, soap, paint pigments and ceramic products; the second is used in the manufacture of aluminum sulphate for purifying water and in the fabricating of refractory materials. Kaolin is a substitute for feldspar in the manufacture of glass and ceramics; and quartz has innumerable applications in industry in general. The discovery was made in Cerro La Tiza, a mountain 16 miles southwest of the capital city, San Juan. It is estimated that the deposit contains 1½ billion tons in all. Puerto Rico has few natural resources to back its industrial development program, and for this reason, the find is heralded as of vast importance to the little island.

* * *

Jet Fuel Icing Control

A lightweight and reliable fuel heater has been developed for jet aircraft by the Garrett Corporation's AiResearch Manufacturing Division, Los Angeles, Calif. The heater was designed because many near accidents involving jet engine power loss have been attributed to ice contamination of fuel systems. This failure occurs because dissolved water is found even in filtered fuels. The moisture is adsorbed and retained in the fuel much as water vapor is held in the atmosphere. As the fuel cools, the water also cools and forms droplets. At about minus 20° F, the droplets become ice slush that obstructs fuel filters and screens. The 18-pound Garrett heater uses hot compressed air ducted through an air-to-liquid heat exchanger to raise fuel temperature to a safe level. Receiving fuel at minus 60° F, the device heats it to

LARGEST EJECTOR



Ready for shipment, one of four huge steam-jet air ejectors made by Ingersoll-Rand Company at its Phillipsburg, N.J., plant is shown above. The ejectors will be installed as components of a vacuum system at Pratt & Whitney Aircraft (division of United Aircraft Corporation) Research & Development Center, West Palm Beach, Fla. When completed, the combined ejector system will be capable of evacuating 2,000,000 cubic feet of air a minute from any one of three test cells. (The test cells will be used to simulate flight conditions in testing jet engines.) Each ejector is 65 feet long and weighs 11 tons. The suction opening is 10 feet in diameter and the throat narrows to about 4 feet before flaring again to 7 feet at the discharge end. A quarter of a million pounds of steam an hour will be used for their operation.

35° to 45° F. Compressor bleed air enters the exchanger at 450° F and exits at 90° F. The exchanger is a plate-and-fin design that consists of multiple parallel plates structurally bonded by brazed fins. A cross parallel flow principle is employed. Both air and fuel enter the heat changer at the same end. The hot air, separated from the fuel by plates and fins, makes several passes at the fuel before it is exhausted to atmosphere. The fuel heaters are being installed on new commercial jet airliners and military aircraft.

* * *

AviSun To Produce Polypropylene

Sun Oil Company scientists have developed a process for the manufacture of polypropylene resins, and American Viscose Corporation researchers have developed new processes for the manufacture of polypropylene film and fibers. The result is AviSun Corporation, an equally owned affiliate of the two companies. It will manufacture, process and sell the resins, film, fibers, elastomers, surface coatings and adhesives, using olefin polymers or copolymers with other substances. Capacity of the firm's plant is estimated to be 20 million pounds per year, making it the largest commercial supplier of polypropylene in the United States. (It is the second polypropylene supplier in the U. S.)

Polypropylene is expected to make possible a host of new or better plastic products at lower cost to the consumer. It is the lightest plastic ever discovered, yet it possesses exceptional toughness and structural strength. It is also the first polyolefin plastic with heat resistance high enough to enable repeated steam sterilization without distortion of shape.

* * *

Lube For High Temperatures

A high-temperature, synthetic lubricating oil for jet engines, recently developed by Celanese Corporation of America and ARDC (Air Research & Development Command), removes one of the major obstacles in the development of supersonic, high-performance aircraft. It has also opened the way for other applications where very high temperatures are encountered. Present lubricants are inadequate for use in some future aircraft because high-speed vehicles will operate in a higher temperature environment due to air friction and the use of more powerful engines. The new lubricant, which will withstand temperatures of 400° F for sustained periods as proved by a test on a full-scale engine, is an ester-type base fluid containing selected additives. A silicon with an analogue of phenothiazine additive was developed by the Materials Laboratory at ARDC's Wright Air Development Center for use as a high-temperature anti-oxidant. Formulation of the lubricant then was accomplished at WADC. The fluid takes its place with several new lubricants developed through studies at Celanese to meet civilian and military synthetic lubrication requirements.

* * *

Canadian Water Power

With the commanding figure of nearly 2,500,000 hp, more than half a million greater than the previous record year of 1954, Canada has recorded her greatest annual increase in hydroelectric generating capacity. The present total installed capacity is about a quarter of the feasible turbine installation, based on Canada's estimated water-power resources. Among the provinces, Ontario recorded the largest annual increase, thanks to the St. Lawrence River power development. The bringing into operation of the Robert H. Saunders-St. Lawrence Generating Station at Barnhart Island added 675,000 hp to the country's total, and it was followed closely by Quebec's contribution of 450,000 hp by the completion of the final three units of the Bersimis 1 development of Quebec Hydro-Electric Commission, a part of which story was told in COMPRESSED AIR MAGAZINE's August 1955 issue. Installations now in the process of being built will bring the Canadian's horsepower figure to 4,500,000 by the end of this year, according to Alvin Hamilton, Minister of Northern Affairs & National Resources.

EDITORIAL

The Highways

TODAY'S highways are one of the wonders of our age. The vast mileage of roads, streets and bridges in the United States is certainly a tribute to the skill and knowledge of engineers and contractors and to the efforts of the government workers behind them. Yet roadways now are almost inadequate to handle the hordes of automobiles setting forth each day on trips around the block or across the country. By 1975, it is estimated, vehicles will travel 1430 billion miles on the highways as compared to the approximately 700 billion miles being traveled today. This doubling of highway use and the effort to catch up with the backlog of needed building has brought about the world's largest single construction effort—an approximately $40 billion program to build the highways required.

The mileage of the roads involved runs to about 40,000 and that works out to $1,000,000 per mile. Although the cost seems quite expensive, the Associated General Contractors of America, Inc., (whose members engaged in highway construction do about 70 percent of the work of that nature being awarded at this time) points out that highways are probably one of the best buys that the public gets for its tax money today.

The average bid price for Federal-aid highway construction in the first quarter of 1959 decreased 0.6 percent from the preceding quarter. In all of 1958, the index increased but 0.3 percent. These figures are in the face of ones pointing out 4.5-percent increases in wages and 3.4-percent increases in certain types of equipment. While some of the contractors' success in holding down over-all costs is due to increasing competition in the field, a great deal more credit certainly should be given to increased efficiency of operation. Part and parcel of this is the greater efficiency of contractor's equipment—its capacity to turn out more work in less time. Big new rock drills with easy-to-set-up mountings, faster haulage equipment, more powerful prime movers, compressors of greater capacity but more portability, all share in the contractors' successes.

WITH all of the emphasis about where we are going in the field of highway construction, and a good deal of talk about how we got into the present situation, it might be of interest to many to review some of the early history of road building in the United States. From the landing of the Pilgrims until about the 1890's, roads were maintained by compulsory unpaid labor following the statute system developed in Britain in the Middle Ages. Roads were designed in that early era by following the path of least resistance.

The first boom in roads came with the first turnpike era. It was initiated by the Philadelphia & Lancaster Turnpike Charter of 1792. The road was 62 miles long, 66 feet wide (20 feet of which was covered with 18 inches of pounded stone) and cost about $7000 a mile. Its success led to other turnpikes and from 1803 to 1807, fifty companies were incorporated in Connecticut alone, 67 in New York and almost as many in Massachusetts. These first roads ably bespoke the quality of the engineering and the ability of the contractors.

In 1806, Congress authorized a "national road" to be built under the supervision of the War Department. The first contract on this 3906-mile route from Washington, D. C., to Los Angeles, Calif., and known variously as the Santa Fe Trail, the Cumberland Road and the National Pike, was awarded in 1811. Its control passed to the States it traverses in 1837. The era of the turnpike was superseded by the epic time of canal builders and, in turn, by the iron horse. Highways were thought to be outmoded and that opinion prevailed until the 1890's and the bicycle boom that immediately preceded the day of the automobile. It was in 1891, under the stimulus of growing bicycle use, that the State of New Jersey passed the first state-aid-for-highways bill.

In that day, horse-drawn construction equipment was the rule and manual labor was all-important. It was not until after 1915 that machines began to replace muscle in highway building. The changes in design of construction equipment that were made then, and that have continued to be made since, have come so rapidly that their effect has often been understated. The use of compressed air and hydraulic controls is often cited as one of the great advances in equipment design because it made it possible to handle the giant equipment of our day. The general use of pneumatic tires where practicable has also been credited with advancing efficiencies. Improvements in explosives and in primary blast hole drills have put a bottleneck operation of the early 1920's into the present day category of a standard procedure and one that keeps other phases of construction working hard to keep up.

IN THE years ahead, the importance of advances in equipment design to the continued ability of this country to afford the roads it needs cannot be underestimated. Full coöperation between the equipment manufacturer, the contractor and the road designer is called for and will be forthcoming as it has in the past. Perhaps one of the important points that should be remembered is that doubling of highway usage over a span of 15 to 20 years has taken place in the past: in 1940, for example, automobiles traveled a total 302 billion miles—a figure that increased to 458 billion in 1950 and 603 billion in 1955. Even more recently, from 1946 to date, it has increased twofold.

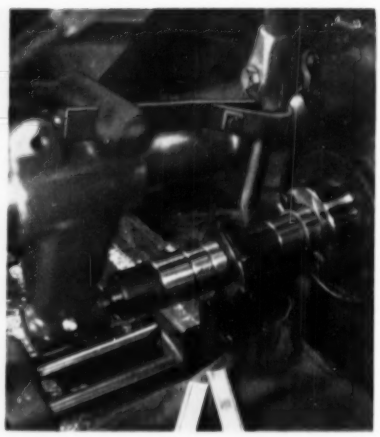
WITH AIR, A SMOOTHER FINISH

SELWYN TUCKER

THE versatility of the simple air gun easily allows it to be used in more ways than for the usual job of chip cleaning around machines. In one case, fitting an air gun to a milling machine changed a rough finish to an exceptionally smooth one.

At a machine shop, gang milling of hard sheet brass by an electro-pneumatic horizontal mill produced a ragged surface. This was a result of chips being rolled and mashed into the workpiece by the mill's cutter teeth. The tool set-up included one interlocking carbide cutter set and one high-speed steel slotting saw. The speed of the set was a relatively low 200 rpm and this low speed was the cause of the finish problems: the working velocity of the tool wasn't fast enough to throw chips clear, and chipping of the carbide teeth was a natural by-product.

To keep the chips off the cutter teeth, several methods were tried. First was the use of a solvent and oil-cutting mixture. This washed the chips into the cut, leaving them mashed—a condition as undesirable as the original one. Next, a simple brush was fitted to clean away the chips. After the cutters caught the brush a few times, this idea was discarded as being dangerous.



Finally a hand-held air gun was tried, using first an interrupted air blast, then a continuous one directed at the cutters from various angles. The experiment indicated that a constant blast from the top, aimed from behind the cutters, proved workable, so the following set-up was made.

A strap clamp was formed from $\frac{1}{8}$ x $\frac{3}{4}$-inch steel. One end was bent into a U shape, then a hole for a clamping bolt was drilled in this section. A larger hole was drilled through the other end so the strap could be bolted to the outboard arbor support. The air gun was inserted and clamped tightly, and the strap was twisted until the most effective air blast angle was found, as shown in the photograph at the left. This angle allowed part of the air stream to blow chips out of the cutter teeth, while the other part continued downward between the cutters. There, the air struck the work, blasting the chips off the surface.

Fingers tired quickly from pressing the air gun trigger, so a trigger lock was made from stiff wire twisted to form a double hook, having a handle. The end hook was locked on the air gun trigger, and the inner hook was engaged over the clamp bolt. With this arrangement, the air stayed on. A flip of the fingers released the trigger lock after each cut.

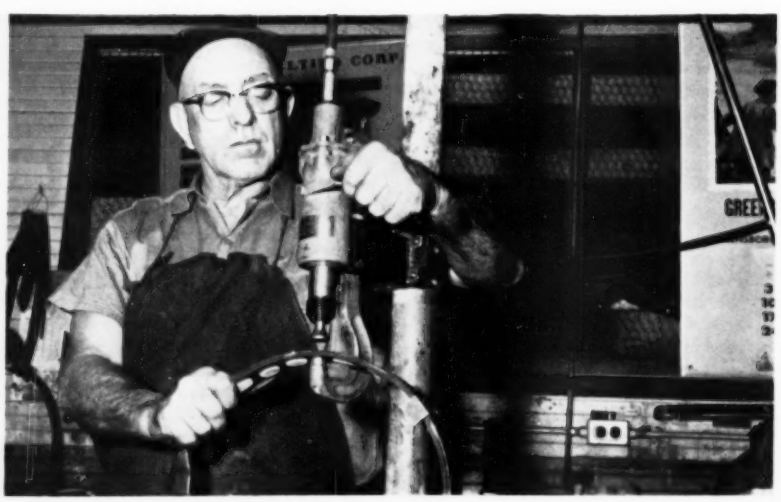
In the past, the finish was only 25-percent smooth. The air blast on the cutters improved the surface to 95-percent smoothness. The device also eliminated the carbide tooth breakage and kept the work cool. Such an air blast, simply applied and readily available in most shops, can be a definite aid to quality production.

SAVING WITH AIR POWER

APPLICATION: LOOM MAINTENANCE

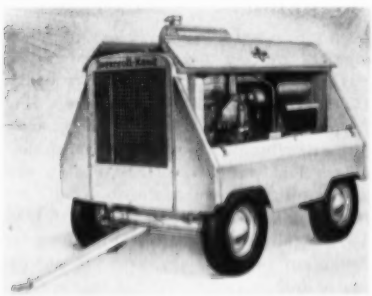
A TEXTILE mill in the South has a central shop where it maintains brake bands and box extensions for looms. Part of the maintenance consists of fastening brake shoes to their bands with nine $\frac{1}{8}$-inch copper rivets, and attaching leather faces to box extensions with three $\frac{1}{16}$-inch rivets. Previously, this important work went very slowly because all of the rivets were manually upset with ball peen hammers.

Then an Ingersoll-Rand air-powered Size AR-130 Airbuck riveter, with a flush set and yoke attachment, was obtained to replace the ball peen tools. The air riveter (at work on a brake shoe in the picture at right) eliminated the production bottleneck and did a faster, better job. Furthermore, it saved $14 per day, the wages of one man for 8 hours.



Industrial Notes

INGERSOLL-RAND has announced the addition of a new 250-cfm size to the company's line of Gyro-Flo compressors. The new size will supersede the Gyro-Flo 210 that has been a member of I-R's portable rotary line for several years. The manufacturer states



that the Gyro-Flo 250, with a completely new compressor system, offers nearly 20 percent more capacity in a unit that is smaller and more compact than its predecessor. It is driven by a larger, more powerful engine, yet retains the same 1800-rpm engine speed. Fuel and air tanks are located under housing and lockable covers. Full-length tool boxes give more storage, and there is provision for easy inspection of all compressor rotor vanes. Side covers fold back safely for accessibility, and a 12-v battery system permits fast starting. The Gyro-Flo 250 offers a choice of two compressor-matched drives: the new General Motors 4-53 diesel engine or the Continental M-363 gasoline engine. The compressor is available with 2- or 4-wheel mounting, or less running gear for truck or skid mounting. The manufacturer reports says that the new Gyro-Flo 250 is the result of user suggestions and intensive research in the field and at the factory. It incorporates, it is said, many new features with many of the Gyro-Flo design features proved for the past 9 years. (Ingersoll-Rand introduced the first portable rotary in the U. S. in 1950.) Form 2931 describes the 250. *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

FLEXIBLE magnets, with permanency claimed to be superior to most conventional types, are made from Koroseal vinyl plastic. The material is compounded and processed to react exactly like metal or ceramic magnets. It can be produced in continuous lengths in sections ranging in size from spaghetti to garden hose. Cutting does not impair its magnetic qualities. Unlike steel types, the plastic magnet can be magnetized in any direction, not only lengthwise. It is attracted to ferrous metals or to itself. The manufacturer is currently producing the magnetic substance at a rate of more than 10 miles per week for use in refrigerator gasket seals. In this application, the strip is used inside a flexible Koroseal gasket to form an airtight seal around the entire perimeter of a refrigerator door. This eliminates the need for a latch because the magnetic strip's strength holds the door closed. Such closures are said to be the most logical immediate application for the new development. *B. F. Goodrich Industrial Products Company*, Marietta, Ohio.

FITTINGS for use in pneumatic, vacuum and hydraulic lines are listed in a catalog, Form No. 259. Included are hydraulic tube fittings, straight thread fittings, reducer couplings, 37-degree flare tube fittings and pipe fittings in many sizes. The standard cadmium-plated steel units are also available in a black phosphate finish; stainless steel ones are marketed in popular sizes and

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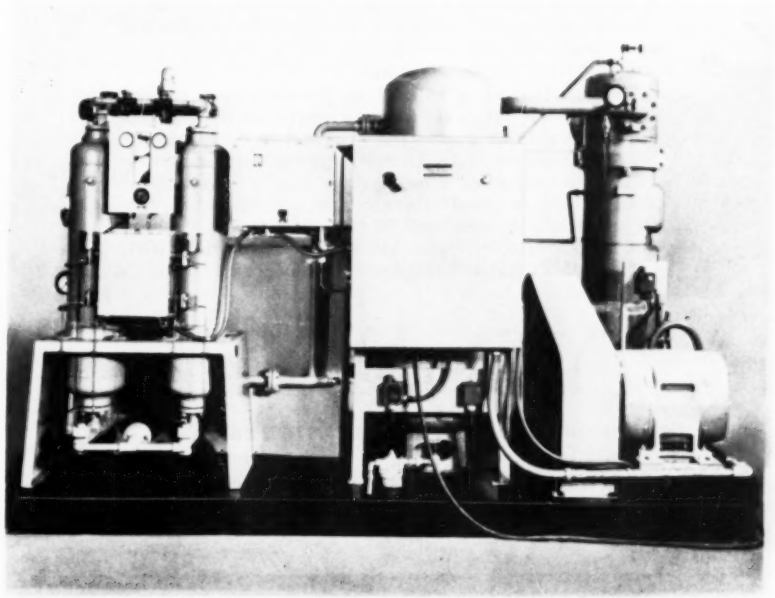
PRESSURIZATION KITS for coaxial or microwave transmission lines, using no heat for reactivation, are available from Trinity Equipment. These completely automatic systems provide dew points to minus 180° F and complete oil rejection. They are said to feature minimum maintenance, elimination of costly electric- or steam-heating facilities, and virtually no corrosion problems. Utilizing a Trinity Heat-Less dynamic dryer, whereby reactivation of the drying chambers is accomplished mechanically through air-pressure changes, the purging systems eliminate the need for costly oil rejection filters. They are designed so that the units may be purchased separately, or in combination, with each interrelating with the other like building blocks. For example, the customer may obtain the dryer alone, or with a compressor and accumulator, or with a complete manifold distribution system, or with instrumentation, control and alarm systems. Both field and factory engineering and design facilities for transmission-line purging systems are offered. Complete technical details and specifications of the pressurization kits are available from the manufacturer. *Trinity Equipment Corporation*, Cortland, N. Y.



shapes. The catalog outlines needle, globe, bleeder and check valves, pressure gauges, filler caps, and such accessories as tube benders and cutters. The tubings listed conform to JIC specifications. *Lenz Company*, 3301 Klepinger Road, Dayton, Ohio.

PVC (polyvinyl chloride) bleeder valves are a part of Walworth's extensive rigid PVC line, which includes Y-globe valves, diaphragm valves, check valves, sediment strainers and pipe fittings. PVC is ideally suited to many applications; it is nontoxic, noncorroding and nonaging. It offers such other advantages as being light in weight, high in burst strength and easy to handle. The valve illustrated can be used for bleeding, sampling or drawing off small amounts of liquid from pipelines, duct systems, tanks and the like. It has no packing and operates as a drain cock on an automobile radiator or steam boiler does. A seal formed by the back seat at the base of the valve stem insures tight closure. Left hand threading causes the valve to close when its hand-wheel is rotated in the standard, clockwise direction. The valve is available in ¾-inch size with male IPS threads. It can be screwed into any threaded ¾-inch female fitting or fixture, or can be

used with appropriate bushings for size adjustments. *Walworth Company*, 750 Third Avenue, New York 17, N. Y.

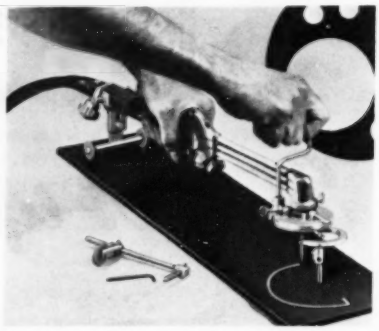
THREE 6-page, 2-color fliers have been published featuring Ingersoll-Rand vertical marine pumps, classes VCM, VBM and VHM. The pumps are volute types with vertically-split casings that permit inspection or dismantling without disturbing suction or discharge nozzles. The pumps' vertical design and accessibility allow installation in a minimum of valuable deck space. VCM, VBM and VHM pumps are designed for main or auxiliary hotwell service, main and auxiliary circulating service, bilge and ballast services and other uses aboard ships. VCM and VBM classes are of single-stage design; the VHM, 2-stage. The VCM handles pressures to 50 psig, capacities of 325 to 22,000 gpm in discharge sizes of 5 to 24 inches and temperatures to 150° F. The VBM takes pressures to 75 psig, capacities of 30 to 650 gpm in sizes of 1, 2 and 3 inches and temperatures to 150° F. VHM pumps handle pressures to 125 psig, capacities of 20 to 400 gpm in sizes of 1, 2 and 4 inches with temperatures to 212° F. Additional information on the features and applications of these pumps is included in the fliers, along with cross-sectional views and external views. The fliers, forms 7591 (VCM), 7592 (VBM) and 7593 (VHM), can be obtained from the manufacturer. *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

PLASTISOL lined pipe fittings in malleable iron or aluminum are supplied with grooved ends, for quick-jointing pipe with the manufacturer's mechanical couplings. The lined fittings are said to extend the simplicity and economy of the quick-jointing method to a wider range of pipe materials. The fittings are available as elbows, tees, reducing tees, reducers, caps and adapter nipples in sizes from 1¼- through 12-inch diameters. The lining is essentially a plastic rubber applied by dipping. It

is seamless, of uniform ⅛-inch thickness and is lapped completely around the ends of the fittings, providing an effective seal with the coupling gasket. While especially designed for use with Plastisol lined pipe, the fittings may also be used with standard-weight pipe, with uncoated interiors, or with linings of rubber, plastic or cement. They are suited as well for use with lined or unlined lightweight steel or aluminum pipe and tubing. The units can handle slurries and abrasive solids in suspension at pressures to 1000 psig. They are resistant to numerous acids, alkalis, salts, plating solutions and organic reagents. Although it will not withstand temperatures as high as will a stainless steel system, it may be installed at lower cost. Couplings may be disassembled as quickly as they are assembled. *Victaulic Company of America*, Elizabeth, N. J.

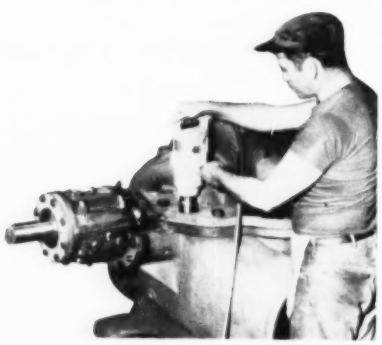
PRECISION holes and various shapes can be cut in thick metal plate with a patented tool that reportedly costs one-tenth that of larger complicated machines. Developed originally for use by the U. S. Navy, the tool attaches to

any acetylene cutting torch for such applications as cutting holes through metal walls and decks for pipe and electrical conduit. Squares, rectangles and odd-shaped holes and solid figures can also be accurately formed for welding fabri-



cations. Because of the tool's small size, it can be operated in confined spaces where laborious and expensive free-hand cutting is usually required. The cutting device is marketed under the name OR-O-CO; information about it may be obtained from the manufacturer. *Ideas, Inc.*, 214 Ivinson Avenue, Laramie, Wyo.

MORE power and the ability to run down nuts and bolts 5 times faster than before are said to be features of the Size 834 air Impactool developed by Ingersoll-Rand. The extra power (25 percent increase) and speed are reportedly due to the new direct drive between motor and hammer which takes full advantage of the inertia of rotating parts. The tool will be of interest to persons concerned with production and maintenance work requiring nut-running operations



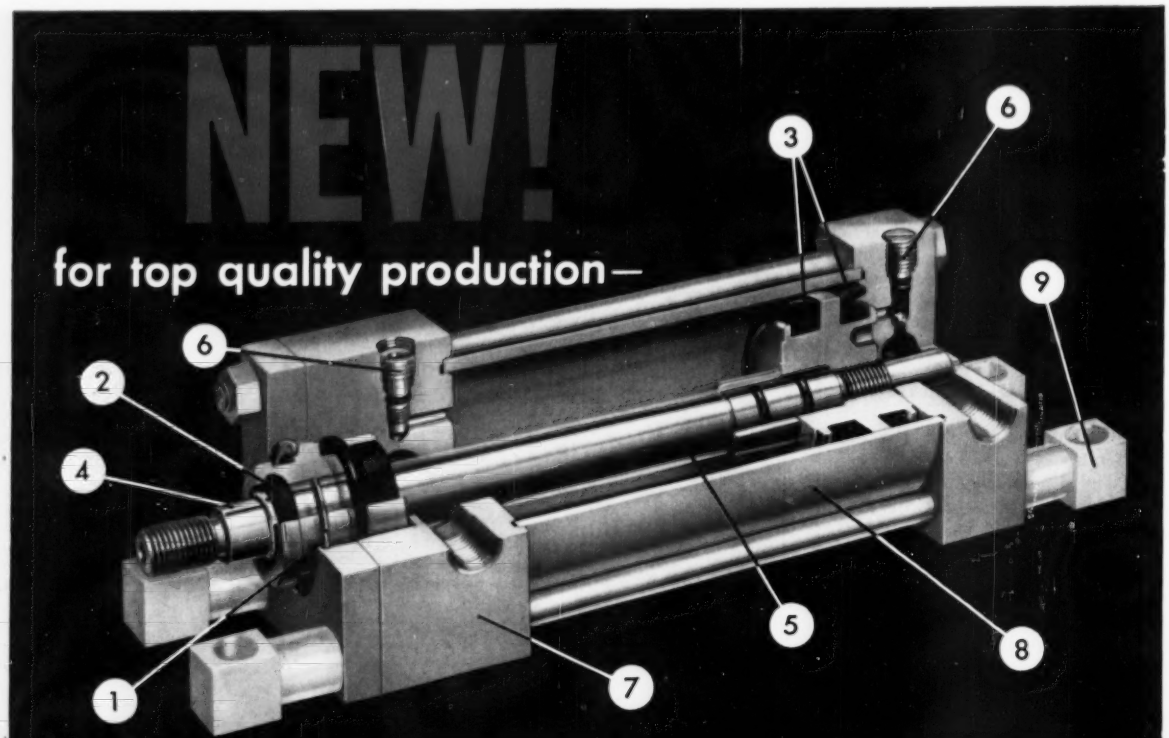
within its rated capacity of 1¼-inch bolt size. New design and construction give the Size 834 Impactool a more favorable power-to-weight ratio; other features of the tool are its larger motor, shorter length and lighter weight. It is 6¾ inches shorter than its predecessor. The tool's compact design plus use of strong, lightweight alloy castings for handle, motor housing and hammer case make the tool 7 pounds lighter, even though the motor is larger than in the

previous size. The impact mechanism is said to operate without transmitting any kick or twist to the operator, and rusted, corroded or frozen nuts can be removed by flicking the reverse lever. The Size 834 spins down nuts with a free speed of 3500 rpm, and delivers 850 powerful impacts per minute. The tool weighs 19⅞ pounds (less socket), has a length of 13 1/16 inches measured to the shoulder of the square driver, and a side-to-center distance of 2 1/16 inches. It is rated to run bolts up to 1¼ inch thread size and has a 1-inch standard square driver. Form 5248 describes the tool. *Ingersoll-Rand Company*, 11 Broadway, New York 4, N. Y.

FUSION welding of Teflon, that allows the assembly of 1-piece lengths or configurations at reduced costs, is being used by the United States Gasket Company, the plastics division of The Garlock Packing Company. The resultant weld is a pure fluorocarbon, retaining, it is said, the chemical, electrical and heat properties of Teflon. Using the welds, solid Teflon gaskets larger than the available sheet size can be economically fabricated from two or more sections. Fusion-welded Teflon is available in thicknesses ranging from 0.015 to 0.375 inch. The maximum length of a straight section weld is 5½ inches, with curved section welds slightly shorter. Strength and elongation across the weld are reported to be excellent. Tests have shown tensile strength in excess of 2500 psi and elongation of more than 200 percent. Tensile factors are estimated to range between 80 and 90 percent of unwelded Teflon. *The United States Gasket Company*, Camden 1, N. J.

AIR-JACKETED silencers that surpress engine noise while they ventilate

"Our welder is an Indian."



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3. "U" Cup Seals expand with pressure to provide positive seal with minimum friction.
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5. Ground, hard chrome-plated Piston Rods have minimum yield strength of 125,000 psi.
6. Self-locking cushion adjusting screw and ball check are below surface for protection . . . easily accessible.
7. For extra strength, Cylinder Ends and Mounting Plates are machined from bar stock and steel forgings.
8. Cylinder is precision-finished brass for extra heavy duty.
9. Variety of mountings can be interchanged—easily match any installation requirement.
10. Interchangeable with all JIC Cylinders.

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meet and exceed JIC specs . . . 250 psi air . . . 750 psi hydraulic!

Here's compact, versatile straight-line power. Just look at the features!

Use Schrader's new square-end double-acting cylinders for holding, positioning, moving work—for push, pull or lifting—for automating manual operations. In five sizes up to 4-inch bore, and with five interchangeable mountings, these "square-ends" are economical and versatile. Bolt, leg, flush, side flush or base . . . each JIC Cylinder will mount all five ways. Suitable for air pressures to 250 psi, or hydraulically to 750 psi—available cushioned or non-cushioned.

You get safe, controlled, low-cost power with Schrader "square-ends"—another addition to the line of famous Schrader quality Air Control Products.

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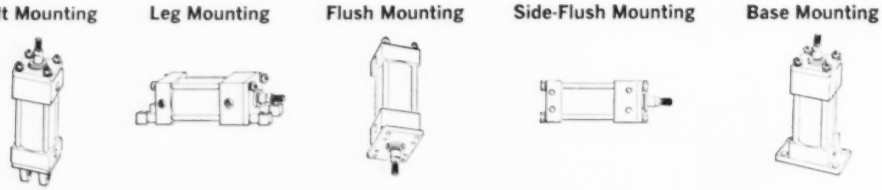

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QUALITY AIR CONTROL PRODUCTS

engine room and surrounding areas are the subject for an illustrated brochure (Data Sheet D-142). Three basic silencing models are mentioned: for use in industrial districts where the noise level is comparatively high and only ordinary silencing is desired; for "semi-residential" areas where the noise level is average; and for critical locations such as hospitals, schools and apartment buildings. Three types of air jacketing are also described. The 4-page booklet gives dimensions and applications of the nine model combinations available. *The Maxim Silencer Company*, 85 Homestead Street, Hartford, Conn.

SMALL enough to weld inside a 3-inch tube, yet powerful enough to carry 200 amperes on continuous duty cycles, the Heliarc HW-20 torch is designed for manual inert-gas tungsten-arc welding. Water-cooling design and high-quality materials and construction reportedly allow this torch to be small in size yet large in performance. It is built to operate on currents to 225 amperes on reduced duty cycles and weighs 3.6 ounces; it is 6⅞ inches long and is equipped with small, flexible service lines that make the device handy to use. Other design features include a leak-proof water cooling system, efficient shielding to save gas, high-frequency safety and easy maintenance. All couplings are standard IAA connections. An argon gas shutoff valve for mounting on the torch handle is available as an accessory. *Linde Company*, Division of Union Carbide Corporation, 30 E. Forty-second Street, New York 17, N. Y.

ROLL-O-MATIC is the trade name of an automatic, renewable-media air filter, the construction and operating characteristics of which are contained in bulletin No. 248-C. Featured in the booklet is a description of the special medium—a 65-foot-long roll of impregnated and reinforced material. It is composed of continuous, interlaced glass filaments held in place by a thermo-setting plastic bond to form a resilient, fluffy blanket having a nominal thickness of 2 inches. The medium reportedly will not drip at temperatures to 150° F and will not lose its adhesive qualities when dry. The filter's construction and

ADAMS FACT FILE #2

PLANT AIR

Moisture Chief Cause of Trouble . . .

Every company today is looking for ways to offset the increased costs of labor, material, equipment and services. At a gasoline station you expect "Free Air", but in industry it is a major expense. Perhaps in your own plant, for an investment in a few minor compressed air system alterations, significant savings are possible.

Water, sludge, rust, oil and dirt in compressed air systems are prime causes of maintenance and production down-time. Water vapor condensing in air lines tends to corrode the piping. Also, water present in the piping may freeze during winter, causing serious reduction of compressed air supply. Such restrictions are often difficult to locate and thaw. This same line moisture may emulsify lube oil destroying its lubricating value and the resultant mixture has high fouling characteristics. Frequently, ice will form within the tool itself since expanding air cools the moisture . . . tool efficiency will be seriously affected.

Some of the Other Problems Created By Wet Compressed Air . . .

Wet compressed air is not only a construction and production tool problem. Faulty paint jobs, contaminated chemical and food products can often be traced to moisture laden compressed air. Waterhammer, unequal pipeline thermal expansion and line leaks also result from collected moisture. In addition, air lost through traps, and in blow-down of compressed air lines provide no useful work . . . represent a sizeable power loss.

You Can Lick Compressed Air Moisture Problem . . .

All of these hidden costs can be virtually eliminated by the installation of an Adams Aftercooler and Cyclone Separator between the compressor and receiver tank. By cooling discharge air to within 10° F. of cooling water temperature — guaranteed with Adams standard Aftercoolers — the moisture can be removed at the separator. Pressure loss is less than one-half pound on these units including the separator. In severe cases, moisture removal of over 90 per cent can be obtained by cooling the air with Adams 2° Aftercooler to within 2° F. of water temperature.

Air Filter for Final Protection at Point of Use . . .

As an added safeguard for expensive tools and equipment, an Adams Poro-Stone Air Filter should be installed just before the air is used. These filters remove all solid material picked up by the air stream. With an Adams Aftercooler, Cyclone Separator and Air Filters clean, dry, trouble-free air is supplied to your production tools. You get continuous service with minimum maintenance.

For further information on how the complete line of Adams air equipment can solve your compressed air problems, write today for your free copy of Bulletin No. 712 on Aftercoolers and Bulletin No. 117 on Poro-Stone Air Filters from the R. P. Adams Company, Inc., 209 East Park Drive, Buffalo 17, New York.

automatic operation are explained, as well as its dimensions and operating capacities. Its design is said to permit economical, on-the-job assembly, and its galvanized steel sectional construction reportedly allows ease of handling. The complete filter, Model B, is shipped in six small cartons and is available in vertical sections of 3, 4 and 5 feet, and in heights from 5 to 15 feet in 4-inch increments. Department PD, *American Air Filter Company, Inc.*, 215 Central Avenue, Louisville 8, Ky.

HERCULES explosives, blasting supplies and, for the first time, blasting agents are listed in the 1959 edition of an 82-page booklet. New ones included are: Dynatex, a nitro-carbo-nitrate agent ideally suited to open-pit mining, quarrying and construction blast work; Kanite nitro-carbo-nitrate agents packed in cylindrical metal containers to provide protection from water; and desensitized high explosives that retain the strength of their respective sensitive grades, but are formulated so that a strong primer or booster is needed for their detonation. The catalog includes a helpful 2-page summary of the properties of the concern's explosives and an index to a description of each. *Hercules Powder Company*, Wilmington 99, Del.

Films . . .

One Hoe for Kalabo is a 16-mm, sound-and-color movie produced by National Machine Tool Builders' Association to explain to the general public what machine tools are and what they do for mankind. The 27½-minute film opens with a sequence in the village of Kalabo in the Zambesi River valley of Africa's Northern Rhodesia. Natives are digging bog iron ore and smelting it in a primitive furnace fed with goat-skin bellows. A whole day's work produces only a small chunk of iron from which is fashioned a single hoe, hence the title. This primitive form of manufacture, unchanged for centuries, is then contrasted with today's modern production methods that help supply conveniences in quantity. Today's civilization, the movie explains, is made possible by power-driven machine tools that can cut and shape metal into autos, typewriters, television sets, generators, food processing machinery, steel-making machinery every type of mechanism for the home or factory. A variety of machining operations is shown so that the work done by machine tools can be seen and understood. Explained are the relationships between machine tools and employment, between machine tools and the standard of living and national defense. One sequence depicts the contrast of old and

new machining methods. First the viewer sees a hoe being pounded out in Kalabo, then the observer is suddenly in one factory after another, witnessing an ever-increasing tempo of production, until finally there is flashed upon the screen a model of a gigantic machine tool. The African sequence of the movie was arranged through the coöperation of the government of Rhodesia. The industrial scenes of the United States were taken in plants in many parts of the country. The film may be obtained by writing to Modern Talking Picture Service, Inc., 3 E. Fifty-fourth Street, New York 22, N. Y.

Books . . .

Standards of the Hydraulic Institute (published by the Hydraulic Institute, 122 E. Forty-second Street, New York 17, N. Y.) has been revised. (The Standards' tenth edition was published in 1956 and reviewed by COMPRESSED AIR MAGAZINE in March of that year.) The pages affected by the revision are available to owners of the Standards and are printed on easily recognizable colored stock for insertion into the original loose leaf cover. The new sheets include the latest technical developments in the industrial pump field. A few important changes are: clarifications and corrections involving drawings, nomenclature and text; new definitions of flooded suction, specific speed and self-priming pumps; dimensions of NEMA type-C face-mounted motors; shaft extension dimensions for NEMA type-P vertical solid shaft ac motors; NPSH charts for centrifugal hot water pumps, single and double suction; revisions in the test code for centrifugal pumps; and calculation of volumetric efficiency of reciprocating pumps, using compressibility factors for water and for hydrocarbons. Total cost, $1.25.

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- Handles more air – with minimum pressure drop.
- Quick connection—and disconnection.
- Instant automatic flow or shut-off.
- Handles any job in your shop using ¾" to ⅛" connections—from the air line to the air tool.
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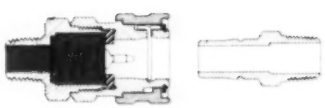
- All Series 2-RL Socket and Plugs are interchangeable—likewise all Series 3-RL Sockets and Plugs. Eliminates any need for various size couplings in hook-up – makes it easy to keep stock of parts in balance—holds inventories to a minimum.



Socket, when disconnected, automatically shuts off air by leak-proof seal of metal valve against rubber valve seat.

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a ready reference when you want information on couplings in a hurry.

Quick-Connective Fluid Line Couplings for

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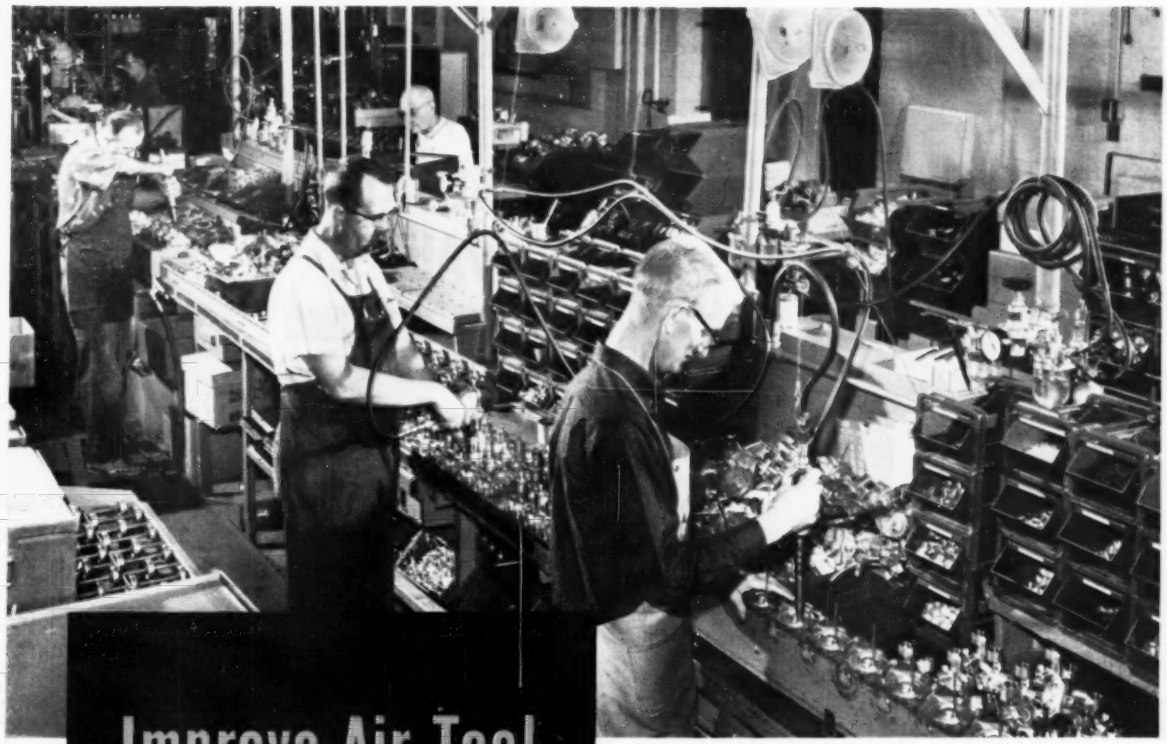
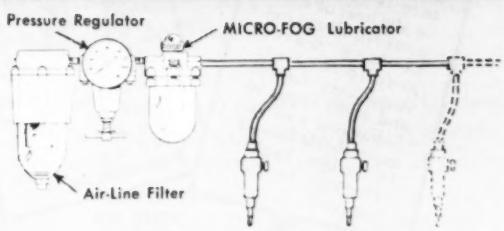


Improve Air Tool Performance

- **INCREASE AIR TOOL LIFE**
- **REDUCE MAINTENANCE COSTS**



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For top air tool performance, it is vital to provide proper air filtration, regulation and lubrication.

1. Norgren Air Line Filters are highly effective in removing damaging abrasive solids and corrosive liquids from the compressed air.

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Results: **Better air tool performance. Less wear of tool parts. Longer service life for tools. Less downtime and maintenance.**

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Completely new from the ground up—backed by 10 years of rotary field experience—this all new Ingersoll-Rand Gyro-Flo 125 portable rotary compressor is based on results of extensive research, performance evaluation and customer suggestions.

Smaller and more compact than the original Gyro-Flo 125, this new unit incorporates many of the proven Gyro-Flo design features plus a host of new features that make it the best 125-cfm portable compressor available.

Some of its features are: larger engines at slower speed (1800-rpm)...60" track for greater stability on rough terrain...full-length tool boxes with more storage capacity...side covers that fold back safely away from operating eye-level...fuel and air tanks under lockable cover to guard against tampering...automatic drainage of oil from cylinders when unit is shut down...and provision for inspection of all rotor vanes. The new Gyro-Flo 125 is powered by 1800-rpm Continental engines—either gasoline or diesel. Ask your Ingersoll-Rand representative for complete details or send today for a copy of Form 2930.

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2-WHEEL MOUNTING	GASOLINE	DIESEL
Weight (dry)	2442	2503
Weight (wet)	2647	2737
Length, incl. draw bar	10'1"	10'1"
Width	5'8¾"	5'8¾"
Height	5'1½"	5'1½"
Track	60"	60"
LESS RUNNING GEAR (INCL. SHIPPING SKID)		
Weight (dry)	2165	2226
Weight (wet)	2370	2450
Length	5'9¾"	5'9¾"
Width	2'8¼"	2'8¼"
Height	3'8¾"	3'9½"

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Fulflo Filters protect your pneumatic equipment by minimizing gumming — removing moisture, oil, microscopic rust, dust, dirt and scale. Here are some examples of Fulflo Filters for a wide range of operating pressures and flow rates. Multi-tube models are available for large flow rates and central installations. Write for new booklet to Dep't CA.

BA Iron & Steel Fulflo Filters
Three sizes — for 3″, 5″ and 7″ Honeycomb Filter Tubes — have maximum operating pressure of 125 psi, maximum flow rate of 150 scfm, with initial pressure loss of only 3 psi. BR7A model is available in nickel-plated brass.

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Maximum flow rate is 180 scfm at maximum operating pressure of 250 psi. 7″ Honeycomb Filter Tube.

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Designed for operating pressures as high as 450 psi. Maximum flow rate is 300 scfm. 7″ Honeycomb Filter Tube.

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Maximum flow rate is 400 scfm at operating pressures up to 750 psi. 10″ Honeycomb Filter Tube.

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High pressure filter has maximum flow rate of 800 scfm, at pressures as high as 4,000 psi. 7″ Honeycomb Filter Tube.

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Among the many hundreds of Allen-Bradley push button and control units, you are certain to find the types best suited to your particular needs. The seven units shown below are a few of the latest additions to the Allen-Bradley *quality* line of control units.

All Allen-Bradley control units—standard duty, heavy duty, and oiltight—have double break, silver alloy contacts—to assure reliable operation. Simple constructions and generous wiring room are outstanding features. Insist on Allen-Bradley control units for *all* of your equipment—you can't go wrong!

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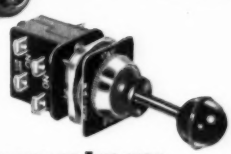
Push-to-Test Pilot Light. Oiltight Bulletin 800T.

Illuminated Push Button. Combines pilot light and push button in one unit. Oiltight Bulletin 800T.



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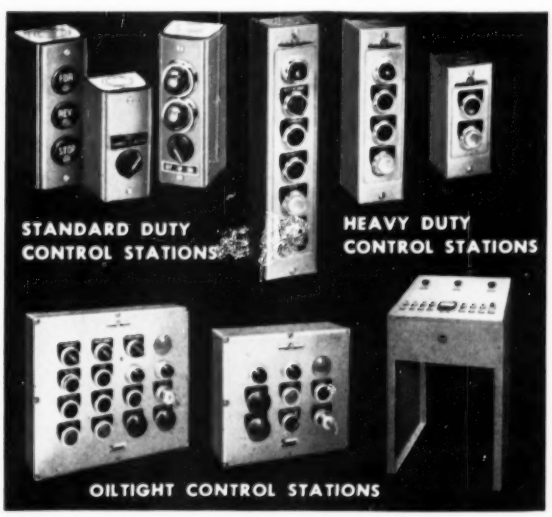

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MOTOR CONTROL

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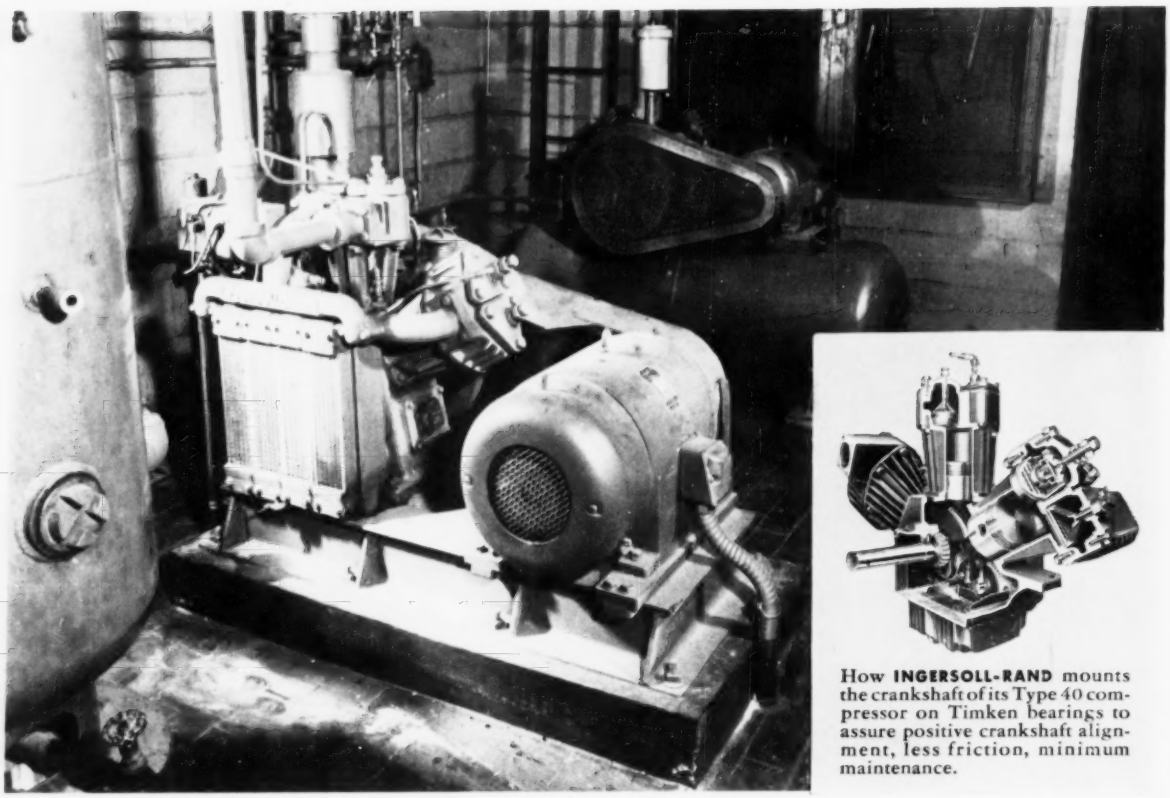

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House air and instrument air are always there, with compressor crankshaft on TIMKEN® bearings

TO make sure this Type 40 air-cooled compressor in a chemical company laboratory will supply dependable house and instrument air, Ingersoll-Rand mounts the crankshaft on Timken® tapered roller bearings.

Timken bearings hold the crankshaft in positive alignment. And they practically eliminate friction. Crankshaft stresses are lower because the use of Timken roller bearings shortens the distance from the center of the Timken main bearing to the center of the crankpin. Crankshaft wear is eliminated; wear on adjacent parts is minimized.

And because they hold housings and shafts concentric, Timken bearings make closures more effective. Dirt and moisture stay out; lubricant stays in.

Timken bearings are geometrically designed and precision-made to roll true. Their taper lets them take *both* radial and thrust loads in any combination. And full-line contact between rollers and races gives Timken bearings extra load-carrying capacity.

To give you greater bearing value, we even make our own electric furnace fine alloy steel. No other American bearing maker does. For all these advantages, specify Timken bearings for the machines you buy or build. They bring Better-ness to any machine because Better-ness rolls on Timken tapered roller bearings. Look for the trade-mark "TIMKEN" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN TAPERED ROLLER BEARINGS ROLL THE LOAD

TRADE-MARK REG. U. S. PAT. OFF.